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ROYAL COMMISSION ON SEWAGE DISPOSAL.

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FOURTH REPORT
OF
THE COMMISSIONERS

APPOINTED IN 1898
TO INQUIRE AND REPORT WHAT METHODS OF
TREATING AND DISPOSING OF SEWAGE
(INCLUDING ANY LIQUID FROM ANY FACTORY OR MANUFACTURING PROCESS)
MAY PROPERLY BE ADOPTED.

POLLUTION OF TIDAL WATERS,
WITH SPECIAL REFERENCE TO
CONTAMINATION OF SHELL-FISH.

VOLUME I.—REPORT.

Presented to both Houses of Parliament by Command of His Majesty.

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VICTORIA R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith: To Our Right Trusty and Right Well-beloved Cousin, Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath; Our Trusty and Well-beloved Sir Richard Thorne Thorne, Knight Commander of Our Most Honourable Order of the Bath, Medical Officer of the Local Government Board; Our Trusty and Well-beloved Constantine Phipps Carey, Esquire, Lieutenant-Colonel and Honorary Major-General on the Retired List of Our Army; Our Trusty and Well-beloved Charles Philip Cotton, Esquire; Our Trusty and Well-beloved Michael Foster, Esquire, Master of Arts, Professor of Physiology in Our University of Cambridge; Our Trusty and Well-beloved Thomas Walter Harding, Esquire, Retired Lieutenant-Colonel of Our Auxiliary Forces, with Honorary Rank of Colonel; Our Trusty and Well-beloved Thomas William Killick, Esquire; Our Trusty and Well-beloved William Ramsay, Esquire, Professor of Chemistry, University College, London; and Our Trusty and Well-beloved James Burn Russell, Esquire, Doctor of Medicine, Master of Surgery: Greeting!

Whereas We have deemed it expedient that a Commission should forthwith issue to inquire and report:

1. (1) What method or methods of treating and disposing of sewage (including any liquid from any factory, or manufacturing process) may properly be adopted, consistently with due regard for the requirements of the existing law, for the protection of the public health, and for the economical and efficient discharge of the duties of local authorities; and

   (2) If more than one method may be so adopted, by what rules, in relation to the nature or volume of sewage, or the population to be served, or other varying circumstances or requirements, should the particular method of treatment and disposal to be adopted be determined; and

2. To make any recommendations which may be deemed desirable with reference to the treatment and disposal of sewage;

Now know ye, that We, reposing great trust and confidence in your knowledge and ability, have authorised and appointed, and do by these Presents authorise and appoint, you, the said Walter Stafford, Earl of Iddesleigh, Sir Richard Thorne Thorne, Constantine Phipps Carey, Charles Philip Cotton, Michael Foster, Thomas Walter Harding, Thomas William Killick, William Ramsay, and James Burn Russell to be Our Commissioners for the purposes of the said Inquiry.

And, for the better effecting the purposes of this, Our Commission, We do by these Presents give and grant unto you, or any three or more of you, full power to call before you such persons as you shall judge likely to afford you any information upon the subject of this Our Commission; and also to call for, have access to, and examine all such books, documents, registers, and records as may afford you the fullest information on the subject, and to inquire of and concerning the premises by all other lawful ways and means whatsoever.

And We do by these Presents authorise and empower you, or any three or more of you, to visit and personally inspect such places as you may deem it expedient so to inspect for the more effectual carrying out of the purposes aforesaid.

And We do further by these Presents will and ordain that this Our Commission shall continue in full force and virtue, and that you, Our said Commissioners, or any three or more of you, may from time to time proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment.

And we do further ordain that you, or any three or more of you, have liberty to report your proceedings under this Our Commission from time to time, if you shall judge it expedient so to do.

And Our further Will and Pleasure is that you do, with as little delay as possible, report to Us under your hands and seals, or under the hands and seals of any three or more of you, your opinion upon the matters herein submitted for your consideration.

And for the purpose of aiding you in such matters, We hereby appoint Our Trusty and Well-beloved Frederick James Willis, Esquire, to be Secretary to this Our Commission.

Given at Our Court at Saint James's, the Seventh day of May, One thousand eight hundred and ninety-eight, in the Sixty-first Year of Our Reign.

By Her Majesty's Command,
(Signed) M. W. RIDLEY.

WILLIAM HENRY POWER, ESQ., F.R.S.,
To be a Member of the Royal Commission on Sewage Disposal.

VICTORIA, R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith: To Our Right Trusty and Well-beloved William Henry Power, Esquire, Fellow of the Royal Society, Medical Officer of the Local Government Board: Greeting!

Whereas We did, by Warrant under Our Royal Sign Manual, bearing date the Seventh day of May, One thousand eight hundred and ninety-eight, appoint Our Right Trusty and Right Well-beloved cousin Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath, together with the several Gentlemen therein mentioned, or any three or more of them, to inquire into the treatment and disposal of sewage.

And Whereas One of the Commissioners so appointed, namely, Sir Richard Thorne Thorne, has since deceased.

Now know Ye, that We, reposing great confidence in you, do, by these Presents, appoint you, the said William Henry Power, to be one of Our Commissioners for the purpose aforesaid, in the room of the said Sir Richard Thorne Thorne, deceased, in addition to, and together with, the other Commissioners whom we have already appointed.

Given at our Court, at Saint James's, the Seventh day of February, One thousand nine hundred, in the Sixty-third Year of Our Reign.

By Her Majesty's Command,

(Signed) M. W. Ridley.

Whitehall, March 18th, 1901.

The King has been pleased to issue a Commission, under His Majesty's Royal Sign Manual, to the following effect:—

EDWARD, R.

Edward the Seventh, by the Grace of God, of the United Kingdom of Great Britain and Ireland King, Defender of the Faith, to all to whom these Presents shall come, Greeting!

Whereas it pleased Her late Majesty from time to time to issue Royal Commissions of Inquiry for various purposes therein specified:

And Whereas in the case of certain of these Commissions, namely, those known as—

The Historical Manuscripts Commission;
The Horse Breeding Commission;
The Local Taxation Commission;
The Port of London Commission;
The Salmon Fisheries Commission; and
The Sewage Disposal Commission;

the Commissioners appointed by Her late Majesty, or such of them as were then acting as Commissioners, were, at the late demise of the Crown, still engaged upon the business entrusted to them:

And whereas We deem it expedient that the said Commissioners should continue their labours in connection with the said inquiries notwithstanding the late demise of the Crown:

Now Know Ye, that We, reposing great trust and confidence in the zeal, discretion, and ability of the present members of each of the said Commissions, do by these Presents authorize them to continue their labours, and do hereby in every essential particular ratify and confirm the terms of the said several Commissions.

And We do further ordain that the said Commissioners do report to Us under their hands and seals, or under the hands and seals of such of their number as may be specified in the said Commissions respectively, their opinion upon the matters presented for their consideration; and that any proceedings which they or any of them may have taken under and in pursuance of the said Commissions since the late demise of the Crown, and before the issue of these Presents shall be deemed and adjudged to have been taken under and in virtue of this Our Commission.

Given at Our Court at Saint James's, the fourth day of March, One thousand nine hundred and one, in the First Year of Our Reign.

By His Majesty's Command,

(Signed) CHAS. T. RITCHIE.

THOMAS JOSEPH STAFFORD, F.R.C.S.I.,
To be a Member of the Royal Commission on Sewage Disposal.

EDWARD R.

Edward the Seventh, by the Grace of God, of the United Kingdom of Great Britian and Ireland and of the British Dominions beyond the Seas King, Defender of the Faith, To Our Trusty and Well-beloved Thomas Joseph Stafford, Esquire, Fellow of the Royal College of Surgeons of Ireland, Medical Commissioner of the Local Government Board for Ireland: Greeting!

Whereas Her late Majesty Queen Victoria did by Warrant under the Royal Sign Manual bearing date the Seventh Day of May One thousand eight hundred and ninety-eight, appoint Our Right Trusty and Right Well-beloved Cousin, Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath, together with the several Gentlemen therein mentioned, to be Commissioners to inquire into the treatment and disposal of Sewage:

And whereas one of the Commissioners so appointed, namely, Our Trusty and Well-beloved Charles Philip Cotton, Esquire, hath humbly tendered unto Us his resignation of his appointment as one of the said Commissioners:

Now Know Ye, that We, reposing great confidence in you, do by these Presents appoint you, the said Thomas Joseph Stafford, to be one of Our Commissioners for the purpose aforesaid, in the room of the said Charles Philip Cotton, resigned, in addition to and together with the present Members of the Commission.

Given at Our Court at Saint James's, the seventh day of May, One thousand nine hundred and two, in the Second Year of Our Reign.

By His Majesty's Command.
(Signed) CHAS. T. RITCHIE.

FOURTH REPORT.

TO THE KING'S MOST EXCELLENT MAJESTY.

May it please Your Majesty.

We, Your Majesty's Commissioners, appointed to inquire into the methods of disposing of Sewage and Trade Effluents, and to make any recommendations in regard thereto, humbly submit this Report concerning the discharge of Sewage and Trade Effluents into tidal waters with special reference to the contamination of shell-fish :—

INTRODUCTORY.

1. The question of the discharge of sewage into tidal waters has recently come into prominence, on account of the serious outbreaks of enteric fever which have been ascribed to the eating of shell-fish obtained from sewage polluted waters.

From time to time, during the past two years we have been furnished by the Local Government Board with copies of numerous communications from Local Authorities in different parts of the country, and Reports by Medical Officers of Health relative to outbreaks of enteric fever and other illness attributed to this cause. These communications from the Local Government Board have also included copies of resolutions passed by Local Authorities representing that, in the interests of the public health, legislation should be promoted for prohibiting the laying down of edible shell-fish in sewage polluted water or other dangerous localities, and for protecting unpolluted layings, storage ponds, fattening beds, and other places where shell-fish are laid or stored, against contamination by sewage. Amongst the authorities who have asked for legislation on these lines, or who have supported the request are the London County Council, the Corporation of the City of London, the Westminster City Council, and the Councils of many other Metropolitan Boroughs, the Corporations of Brighton and Southampton, and the Rural District Council of Chelmsford.

It has also been stated that there is an undue amount of enteric fever and other illness on the banks of polluted rivers and estuaries, especially where there is much mud exposed, and that offensive putrefaction, injury to, and destruction of, fish, the formation of sludge banks and the dangerous contamination of bathing places, are other evils due to sewage pollution.

THE LAW IN REGARD TO THE POLLUTION OF TIDAL WATERS.

It may be convenient to refer to the chief statutory provisions to which our attention has been drawn.

2. Section 17 of the Public Health Act, 1875, provides that "nothing in "this Act shall authorise any Local Authority to make or use any sewer, Adrian, 90.
"drain or outfall for the purpose of conveying sewage or filthy water into "any natural stream or watercourse, or into any canal, pond or lake until "such sewage or filthy water is freed from all excrementitious or other foul "or noxious matter, such as would affect or deteriorate the purity and "quality of the water in such stream or watercourse or in such canal, pond "or lake."

This Section has not been interpreted as applying to tidal waters.

3. The Rivers Pollution Prevention Act, 1876, exempts tidal waters from its operation, but power is given to the Local Government Board Adrian, **92x; 158**
to make orders extending the operation of the Act to such portions

of the sea or tidal rivers as they may, after local inquiry, and "on sanitary grounds," deem necessary. This power has not been widely used.

4. Section 5 of the Salmon Fishery Act, 1861, provides that:—

"Every person who causes or knowingly permits to flow, or puts or knowingly permits to be "put, into any waters containing salmon, or into any tributaries thereof, any liquid or solid "matter to such an extent as to cause the waters to poison or kill fish, shall incur the following "penalties (that is to say):—

"(1) Upon the first conviction a penalty not exceeding five pounds:

"(2) Upon the second conviction a penalty not exceeding ten pounds, and a further "penalty not exceeding two pounds for every day during which such offence is continued:

"(3) Upon a third or any subsequent conviction a penalty not exceeding twenty pounds "a day for every day during which such offence is continued, commencing from the date of "the third conviction:

"But no person shall be subject to the foregoing penalties for any act done in the exercise of any "right to which he is by law entitled, if he prove to the satisfaction of the court before whom he "is tried that he has used the best practicable means, within a reasonable cost, to render harmless "the liquid or solid matter so permitted to flow or to be put into waters; but nothing herein "contained shall prevent any person from acquiring a legal right in cases where he would have "acquired it if this Act had not been passed, or exempt any person from any punishment to which "he would otherwise be subject, or legalize any act or default that would, but for this Act, be "deemed to be a nuisance or otherwise be contrary to law."

Section 13 of the Salmon Fisheries (Scotland) Act, 1862, is as follows:—

"Every person who causes or knowingly permits to flow or puts or knowingly permits to be put "into any river containing salmon, any liquid or solid matter poisonous or deleterious to salmon, "or who shall discharge into any river sawdust to an extent injurious to any salmon fishery, shall "be liable to the following penalties (that is to say):—

"For the first offence a penalty not exceeding five pounds:

"For the second offence a penalty not exceeding ten pounds, and a further penalty not "exceeding two pounds for every day during which such offence is continued:

"For the third or any subsequent offence a penalty not exceeding twenty pounds, and a "further penalty not exceeding five pounds for every day during which such offence is "continued.

"But no person shall be subject to the foregoing penalties for any act done in the exercise of any "right to which he is by law entitled, if he prove to the satisfaction of the court before whom he "is tried that he has used the best practicable means, within a reasonable cost, to dispose of or "render harmless the liquid or solid matter so permitted to flow or to be put into waters; but "nothing herein contained shall prevent any person from acquiring a legal right in cases where he "would have acquired it if this Act had not passed, or exempt any person from any punishment "to which he would otherwise be subject, or legalize any act or default that would but for this "Act be contrary to law."

Cd. 1198, (1902) page 44.

5. As regards these sections, the Royal Commission on Salmon Fisheries in their Report of the 10th of July, 1902, made the following observations:—

"Under the existing Salmon Fishery Acts it is necessary to prove that the pollution complained "of has poisoned or killed fish in England, or has poisoned, or been deleterious to salmon to an "extent injurious to any salmon fishery in Scotland, or has poisoned or killed any salmon or smolt "in the Tweed, but it is by no means easy to establish a sufficient case, and, further, under the "English and Scotch General Acts, no person is liable if he prove to the satisfaction of the Court that "he has used the best practicable means, within a reasonable cost, to render the pollution harmless."

"We are of opinion that Section 13, Salmon Fisheries (Scotland) Act, 1862, should be "amended by striking out the words, 'to an extent injurious to any salmon fishery,' and think "it desirable that Section 5, Salmon Fishery (England) Act, 1861, should be made to conform "with the Scottish Section so amended."

6. As regards the protection of sea fish generally (including shell-fish) we may refer to Section 2 of the Sea Fisheries Regulations Act, 1888, which authorises Sea Fisheries Committees to make bye-laws "for prohibiting or regulating the deposit or discharge of any solid or liquid substance detrimental to sea fish or sea fishing." By the definition in the Act "sea fish" includes "shell fish." The expression "sea fishing" is not defined; we assume that it refers to the industry.

Section 13 of this Act, however, provides that "nothing in this Act shall "authorise a local fisheries committee to make any bye-law . . . . "(c) affecting any power of a sanitary or other local authority to discharge "sewage in pursuance of any power given by a general or local Act of "Parliament, or by a Provisional Order confirmed by Parliament."

7. The byelaws authorised by this Act require confirmation by the Board of Trade, and as to their scope we may refer to the evidence (8782—8787) given before us by the Hon. T. H. W. Pelham, Assistant Secretary to the Fisheries Department of the Board of Trade. Pelham, 8782-8787.

The Board of Trade have taken the view that the proviso of section 13 renders such byelaws inapplicable to the discharge of sewage by local authorities on the ground that the authorities are "acting under the Public Health Act" (8786).

A similar view was also expressed to us by Mr. Gibson, the Clerk to the Kent and Essex Sea Fisheries District Committee. Gibson, 16568; 16672, *et seq.*

8. The interpretation which has been adopted by the Board of Trade as to the scope of these byelaws is possibly the right one, but we were informed that the point had not been decided by the Courts, and as neither witness referred us to any section in any general Act of Parliament giving power to local authorities to discharge unpurified sewage into tidal waters, and we have not been able to discover any such section, we are not entirely satisfied that the proviso has the effect which has been attributed to it.

It is true that the Rivers Pollution Prevention Acts do not prohibit the discharge of sewage into tidal waters, but the absence of a prohibition would scarcely seem to be equivalent to the giving of a power, within the meaning of section 13 of the Sea Fisheries Regulation Act, and apart from the view which has been adopted by the Board of Trade it might perhaps have been considered that the byelaws authorised by that Act would have applied to the discharge of sewage where such discharge was detrimental to sea fish or sea-fishing, and no Local Act or Provisional Order was in force giving the Local Authorities power so to discharge it.

9. In addition to statutory provisions it may be observed that certain actions have shewn that Local Authorities may under the common law be restrained from discharging crude sewage into tidal waters to the injury of others. As a case in point we may refer to Lord Gifford *v.* the Corporation of Chichester in which an injunction was obtained. "The Times," June 29th, 1901.

10. Generally speaking, therefore, it may be said that the Statute law does not prohibit the discharge of polluting liquids into tidal waters.

OBJECTS OF OUR INVESTIGATIONS.

11. We find that sewage and trade effluents from towns on tidal rivers and on the coast are usually discharged in an unpurified condition into tidal waters. The investigations of the Commission have been directed to ascertaining whether this is a proper method of disposing of such matters, and if not, in what circumstances such discharge is productive of injury, what is the nature and extent of the injury, and what remedies are practicable and available.

Throughout this branch of our inquiry we have received valuable assistance from Dr. H. Timbrell Bulstrode, one of the Medical Inspectors of the Local Government Board, who has made a special study of the contamination of shell-fish.

METHOD OF INVESTIGATION.

12. In February, 1901, the following Circular Letter was sent to the County Council of every County in England and Wales having a sea-board, thirty-one in all:

"27th February, 1901.

"Sir,

"The Royal Commission on Sewage Disposal are considering under what circumstances "the discharge of sewage or sewage effluents into tidal waters, estuaries, and the sea may "properly be allowed, and they would be glad to know whether the Medical Officer of Health or "any other officer of the County Council has any evidence on the following or similar points:—

"1. Whether the discharge of crude sewage (either alone or mixed with manufacturing "refuse), or the discharge of manufacturing refuse alone, into such waters, is, or might be, "dangerous to health, injurious to fish, oysters, &c., or the cause of nuisance.

"2. Whether the discharge into such waters, of an effluent, which, judged from chemical "standards alone, is satisfactory, but which contains large numbers of the bacteria common to "sewage, is, or might be, dangerous to health, injurious to fish, oysters, &c., or the cause of "nuisance.

"If so, the Commission would be glad to be informed briefly of the nature of such evidence.

"I am, Sir,
"Your obedient Servant,
"(Signed) F. J. WILLIS,
"*Secretary.*

"The Clerk of the County Council."

13. Of the thirty-one County Councils to whom the Circular Letter was sent, twenty-one had no evidence to offer on the questions raised. From other County Councils the Commission received copies of Reports and other information, as follows:

Cheshire.—The County Council referred to a report by Dr. Bruce Low, Medical Inspector of the Local Government Board, dated September, 1895, and a report by the Medical Officer of Health, dated 1897. These reports contain information as to pollution of the Dee, including tidal portions, and of rivers and streams draining thereto. In the report by Dr. Low, there is evidence of the destruction of salmon by the pollution of the Dee, through the discharge into it of unpurified sewage and manufacturing refuse, and in the Appendix to that Report is given a letter from the River Superintendent as to the destruction of salmon by pollution.

Cornwall.—The County Council forwarded extracts from Reports by the Medical Officer of Health for the Rural District of East Kerrier, in which that officer expresses the opinion that several cases of typhoid fever in the Rural District were due to and followed the eating of oysters and cockles obtained from waters contaminated by sewage.

Lincoln, Holland, Parts of.—The County Council stated that the liquid discharged from a railway creosoting yard into the Witham at a point 6 or 7 miles from its mouth had been found to be very injurious to mussel beds in the Wash.

Isle of Wight.—The County Council forwarded reports from the Medical Officers of Health for several districts (including the Rural District). These reports shew generally that there is no evidence of nuisance or injury caused by the discharge of sewage, &c., into tidal waters so far as the Isle of Wight is concerned; but the Medical Officer of Health for the Rural District is of opinion that fish, especially oysters, are prejudicially affected at the mouth of a sewer by both crude sewage and bacterial effluents.

Northumberland.—The County Council forwarded a letter from the County Medical Officer of Health, in which it was stated that there had been a few cases in which the discharge of crude sewage and manufacturing refuse into tidal rivers, &c., had probably been injurious to health and a cause of nuisance. The Medical Officer of Health also stated that he had known instances of poisoning of fish by discharge of trade refuse and sheep dipping fluid into streams, but not as regards tidal rivers, estuaries, or the sea.

West Sussex.—The County Council themselves had no evidence to offer; but the Clerk stated, in his capacity as Clerk of the Sussex Sea Fisheries Committee, that he had become acquainted with cases of nuisance and injury caused to sea fishing by the discharge of sewage into tidal waters, viz., into those of the Adur at Shoreham and of Chichester Harbour.

14. Of the remaining County Councils to whom the Circular Letter was sent, three were represented before the Commission by their respective Medical Officers of Health, viz.—

Dr. J. C. Thresh, County of Essex.	8835-9027 18024-18172
Dr. Eustace Hill, County of Durham.	9028-9125
Dr. W. Williams, County of Glamorgan.	9818-9924

On the suggestion of the Lancashire County Council, the Commission called Professor Herdman, of the University College, Liverpool, Scientific Adviser to the Lancashire and Western Sea Fisheries Committee. 8670-8766 18173-18375

15. The Commission have also examined the following witnesses :—

The Hon. T. H. W. Pelham, Assistant Secretary to the Board of Trade Fisheries and Harbour Department.	8767-8834
Dr. H. T. Bulstrode, M.A., Medical Inspector of the Local Government Board.	15692-15840 19722 *et seq.*
Dr. E. Klein, F.R.S.	9613-9817 17663-17841
Mr. E. A. Letts, D.Sc., Ph.D., Professor of Chemistry at Queen's College, Belfast.	8573-8669 13510-13582
Mr. W. D. Adeney, D.Sc., F.I.C.	13222-13299
Dr. Lorrain Smith, Professor of Pathology at the Queen's College Belfast.	13583-13674
Dr. T. J. Browne, Medical Inspector of the Local Government Board, Ireland.	19360-19483.
Professor E. J. McWeeney, M.A., M.D., D.P.H., Bacteriologist to the Local Government Board for Ireland.	19484-19578.
Mr. E. W. L. Holt, Scientific Adviser to the Department of Agriculture, Ireland.	19579-19617.

Medical Officers of Health.

Dr. J. T. C. Nash, Borough of Southend-on-Sea.	17169-17307
Dr. J. Blamey, Urban District of Penryn and Rural District of East Kerrier, Cornwall.	17418-17536
Dr. Arthur Newsholme, Borough of Brighton.	17537-17662
Dr. James Niven, City of Manchester.	17843-18023
Dr. Savage, Borough of Colchester.	18419-18491
Dr. Herbert Williams, Port of London.	18790-18861
Mr. Shirley Murphy, County of London.	18862-19023

Representatives of Sea Fisheries District Committees.

Mr. Robert Arthur Dawson, Lancashire and Western Sea Fisheries District.	16298-16419
Mr. Herbert Donnison, Eastern Sea Fisheries District.	16420-16533
Mr. Herbert William Gibson, Kent and Essex Fisheries District.	16534-16703
Sir William Pink and Mr. St. Barbe, Southern Sea Fisheries District.	16951-16977

Representatives of the Shell-fish Industry.

Captain Anderson, Chairman of the Whitstable Oyster Company.	16020-16213
Sir Charles Petrie, Alderman of the City of Liverpool.	16214-16279
Mr. J. Wrench-Towse, Clerk to the Fishmongers' Company, London.	16280-16297 19618-19721
Mr. John Cole, Oyster Merchant, Poole.	16704-16756
Mr. Adam E. Scott, Oyster Merchant, Poole.	16757-16831
Mr. Alfred Brazier, Oyster Merchant, Southwick.	16832-16888
Mr. John Kennett, Oyster Merchant, Emsworth.	16889-16950
Mr. Willoughby John Bean, Oyster Merchant, West Mersea.	17308-17417

16978-17168 Mr. G. H. Baxter, representing the Chamber of Fisheries.

18376-14818 Mr. J. H. Barber, Secretary of the Chamber of Fisheries and the London Fish Trade Association.

Representatives of the London County Council.

18492-18634 Mr. Maurice Fitzmaurice, Chief Engineer.

18635-18789 Professor Frank Clowes, D.Sc., F.I.C., Chemist.

16. In addition to taking a large amount of evidence on the subject, we have visited several centres of the shell-fish industry for the purpose of investigating the local conditions and of considering what remedies might be adopted for obviating dangerous contamination by sewage of the shell-fish in beds, layings, and ponds.

The places visited were Hayling Island, Emsworth, Bosham, Shoreham, Southwick, and Brighton; Burnham-on-Crouch, the oyster layings in the Crouch, the fattening beds and storage ponds in the Roach River, the Brightlingsea creek, the oyster fisheries in the Colne and Pyfleet, Colchester, and West Mersea, in Essex; and Sheringham, Cley, Blakeney, Stiffkey, Wells, Brancaster, Hunstanton, The Wash, and Boston, on the East Coast.

17. Our inspection of the fisheries in Essex was greatly facilitated by the Colne Fishery Board, the Roach River Oyster Fishery Company, and the Burnham Oyster Company, who placed their steamers and boats at our disposal and appointed representatives to accompany us. We are also indebted to Mr. Willoughby Bean, of West Mersea, for facilities afforded by him for the inspection of the oyster fisheries at that place, and to Mr. Gann for his assistance during our visit to the Hayling Island fisheries.

On our visit to the fishing centres on the East Coast, we received much assistance from the Eastern Sea Fisheries District Committee, who gave us the use of their steamer and allowed their Chief Inspector, Mr. Herbert Donnison, to accompany us to the several places visited.

It is impossible to mention the names of all those who have rendered us aid, but we may say that we have invariably received willing assistance from all concerned.

18. We have carried out numerous scientific investigations which are dealt with in a later section of this report. Full details of these inquiries are contained in the Appendix which is issued with this report. (Volume III.)

19. At this stage we may state generally that we are satisfied that injuries to health and to fisheries may be caused by the discharge of unpurified sewage into tidal waters, and that some alteration of the law is required. A change in the law is especially needed in the case of tidal waters in which shell-fish are laid but there are other evils besides the contamination of shell-fish to be guarded against, amongst which may be mentioned the following:—

1. Offensive putrefaction.
2. Reduction of Oxygen to such an extent as to render the water incapable of supporting fish life.
3. Destruction of fish by poisons or the clogging of their gills by suspended matters.
4. Washing up of fœcal matter on the shore.
5. Formation of sludge banks.
6. Objectionable contamination of bathing places.

CONTAMINATION OF SHELL-FISH.

Possibility of Communication of Disease through Shell-fish.

Shell-fish.

20. We have no doubt that shell-fish which have become contaminated by sewage may convey enteric fever and other illness to human beings if eaten, either raw, or in an imperfectly cooked condition.

This view has been held for many years by competent observers. In the year 1880, Sir Charles Cameron read a paper before the British Medical Association at Cambridge entitled, "Typhoid from Oysters," (13051). Since that time a considerable amount of evidence has been accumulated, and we observe that the Chairman of the Lords Committee on the Oyster Bill of 1899, stated that the Committee accepted "the principle that it is possible to communicate typhoid through the oyster, or something in the oyster."

It is not therefore necessary for us to do anything more than very briefly to indicate the grounds of our conclusion.

Report of Sir Richard Thorne Thorne of Oct. 1896 (C. 8214). Browne, 19360, *et seq.*

21. In the first place it is clear from the exhaustive survey of the oyster fisheries of England and Wales, which was made by Dr. Bulstrode in 1894 and 1895, and from a similar survey made this year in Ireland by Dr. Browne, that many layings and ponds around our coasts are so situated that sewage may reach them in a very short time after its discharge from the outfall; and it is well-known that micro-organisms of intestinal origin may be taken up by shell-fish from the water in which they are lying and may remain alive in them for several days.

On *primâ facie* grounds, therefore, it would seem probable that at times the typhoid bacillus in a living condition might be conveyed by shell-fish to the consumer and produce in him enteric fever.

22. Experience confirms this view. There have been numerous instances in which several persons have been simultaneously seized with enteric fever, and the only discovered competent cause common to all the cases was the eating of shell-fish.

In some of these instances the source of the shell-fish has been traced and it has been found that it was so situated as to be obviously liable to sewage contamination.

23. A most careful and complete investigation of such an outbreak of enteric fever and other illness following the Mayors' banquets at Winchester and Southampton in November, 1902, was made by Dr. H. Timbrell Bulstrode, and his Report thereon to the Local Government Board, dated the 14th of May, 1903, is an important contribution to the subject.

After stating in full detail the steps which he took in this investigation and the information which he obtained, he summarises the position as follows :—

> " 1. *Two* Mayoral banquets occur on *the same day* in separate towns several miles apart.
>
> " 2. In connection with each banquet there occurs illness of analogous nature attacking, " approximately speaking, the same percentage of guests and at corresponding intervals.
>
> " 3. At both banquets not every guest partook of oysters, but all those guests who suffered " enteric fever and approximately all those who suffered other illness did partake of oysters. The " exceptions to this rule appear insignificant when all the facts are marshalled.
>
> " 4. Oysters derived directly from the same source constituted the only article of food which " was common to the guests attacked.
>
> " 5. *Oysters from this source* were at the same time and in other places proving themselves " competent causes of enteric fever.
>
> " *Conclusion.*
>
> " The foregoing narrative of facts would seem to establish the strongest possible presumption " that oysters which had been deposited for a time at Emsworth have caused the outbreaks of " enteric fever and other illness which followed the Mayoral banquets on November 10th at " Winchester and Southampton."

24. The cumulative effect of evidence of this character, taken in conjunction with our knowledge of the conditions, seems to us to justify the conclusion that shell-fish contaminated by sewage may produce enteric fever and other illness in human beings.

Shell-fish.

Moreover, it will be observed from the evidence that the Medical Officers of Health and other scientific witnesses whom we have examined hold this view, and that, speaking generally, the representatives of the shell-fish industry do not now seriously contend that it is unsound.

Herdman, 8675–7; 8693–4; 8703–8; 18174; Klein, 9613; Bulstrode, 15708; Cameron, 13051–3; 13164–76; Nash, 17170; Blamey, 17419; Newsholme, 17538; Niven, 17844; Thresh, 18025; Savage, 18422; Murphy, 18862.

25. We may also refer to the following opinion of the late Professor Huxley, which was brought to our notice by Mr. Pelham, Assistant Secretary to the Board of Trade :—

Pelham, 8769.

"I do not see how it can be doubted that oysters taken from a bed irrigated with dilute " sewage and eaten uncooked would be dangerous articles of diet. Does anybody pretend that " it would be safe to take drinking water (unfiltered and otherwise unpurified) from a body of " fresh water, of similar dimensions to any estuary which may be under consideration, at a point " equally near a sewage discharge? If such a proceeding is safe, our sanitary authorities are " taking a great deal of trouble in vain: if it is not safe, neither is it desirable to eat oysters, " the juices of which are impregnated with sewage, in however dilute a condition."

EXTENT OF DISEASE DUE TO THE CONSUMPTION OF CONTAMINATED SHELL-FISH.

26. Before considering what remedies should be adopted, it appeared to us desirable to obtain some idea of the extent to which enteric fever and other illness may be due to the consumption of contaminated shell-fish, and it will be seen that we have taken a considerable amount of evidence on this question. *Shell-fish.*

We may refer particularly to the evidence of

Dr. J. T. C. Nash, Medical Officer of Health, Southend-on-Sea, 17170–17303.

Dr. A. Newsholme, Medical Officer of Health, Brighton, 17538–17662.

Dr. James Niven, Medical Officer of Health, Manchester, 17844 *et seq.*

Mr. Shirley Murphy, Medical Officer of Health, County of London, 18862 *et seq.*

These witnesses have made a special study of the subject, and have collected valuable data.

27. The effect of their evidence on this point is as follows :—

Dr. J. T. C. Nash.—From special researches made in 1902 into the causation of typhoid fever in Southend-on-Sea, Dr. Nash came to the conclusion that at least 50 per cent. of the cases in that year were due to the consumption of shell-fish from sources contaminated by sewage. This indeed, in his opinion, understates the limit, as he found that out of 105 cases of typhoid fever in that year there was some connection with shell-fish in at least 82 cases. In addition to the definite cases of typhoid fever, there were cases of diarrhœa in several other persons who had eaten shell-fish (cockles) from a polluted source. The history of each case was carefully traced, and other possible causes of the disease investigated.

Dr. Nash also quoted figures of typhoid notification in Yarmouth for each month of the years 1897 to 1902. In 1900, after a series of years of endemic typhoid in this town, the sale of mussels from the Yare was stopped, and in 1901, there was a marked reduction in the number of notifications (amounting to 30 per cent. below the monthly means of previous years), and in 1902 a still further reduction.

Dr. A. Newsholme.—Submitted a tabular statement of the number of cases of enteric fever in Brighton during the years 1894 to 1902, distinguishing those which, in his opinion, were caused by oysters and other shell-fish. This table indicates that, out of 643 cases, 158 cases were directly ascribable to the consumption of oysters, and 80 cases to the consumption of other shell-fish within the period of incubation. In other words, that 37 per cent. of the total cases of enteric fever during these years were ascribable to shell-fish. The history of each case was traced, and cases of typhoid fever were only put down to the shell-fish after the apparent exclusion of every other possible cause. The shell-fish were traced to particular layings which were proved to be exposed to sewage contamination, and typhoid fever was found to exist among the population draining to the vicinity of the layings. In the opinion of Dr. Newsholme, the extent of the illness attributable to shell-fish is understated in the above figures.

Dr. James Niven.—Submitted a tabular statement of the number of cases of enteric fever in Manchester during the years 1897 to 1902, inclusive. This table shows that in that period there were 2,664 cases of enteric fever, of which number 274 were associated with the consumption of shell-fish, 118 being strictly ascribable to mussels and oysters. In arriving at the latter figure, all other possible causes were considered, and all doubtful cases were rejected. Owing to gaps in the figures, the number of cases due to shell-fish is probably understated.

Mr. Shirley Murphy.—The information supplied by Medical Officers of Health of Metropolitan Boroughs tended to show that in 8 per cent. of the cases of enteric fever which occurred in London in 1902, the patient had eaten shell-fish at a time before the attack that was consistent with such shell-fish having been the cause of the disease. It was not possible, however, to make a definite statement as to what the proportion really was, and Mr. Shirley Murphy was inclined to think that 8 per cent. fell short of the number that would have been obtained if full inquiries could have been made.

28. We may also refer to the report of Dr. Nash for the month of September, 1903, to the Public Health Committee of the Southend Corporation, from which the following extract is taken.

" *Typhoid Fever and Shell-fish.*

" I have brought this subject forward so many times before the Committee that it may be " thought unnecessary to broach the subject again.

" On the contrary, the evidence I get as to the connection between shell-fish and typhoid " becomes more striking than ever, and I reiterate my opinion that considerably more than " 50 per cent. of the cases of typhoid fever which occur in Southend are caused by contaminated " shell-fish. In other words, in my opinion, a *known* and *preventable* cause exists, and I submit that " this being the opinion of your medical officer, the Council should do everything possible to " minimise this evil."

CONCLUSION OF COMMISSION AS TO EXTENT OF ILLNESS ATTRIBUTABLE TO THE CONSUMPTON OF CONTAMINATED SHELL-FISH.

Shell-fish. 29. After carefully considering the whole of the evidence on this point, we are satisfied that a considerable number of cases of enteric fever and other illness are caused by the consumption of shell-fish which have been exposed to sewage contamination; but, in the present state of knowledge, we do not think it possible to make an accurate numerical statement, at any rate as regards the whole country.

In certain towns the subject has received much consideration, and the Medical Officers of Health have been at considerable trouble to collect all available data, but we doubt whether this practice has been universally adopted throughout the country.

Moreover, an examination of the figures which have been placed before us as regards those towns in which the subject has been most carefully studied, shows that there may be occasional errors. Indeed, the witnesses themselves recognised that absolutely accurate figures are not obtainable.

Isolated cases of enteric fever have been ascribed to shell-fish where the patient had eaten shell-fish obtained from a contaminated source, at a period prior to the manifestation of the disease corresponding with the incubation period, and no other source of infection was discovered.

We are far from denying that such *isolated* cases may have been due to contaminated shell-fish, but when we remember the numerous unexplained cases of enteric fever, we feel that the possibility of some of them being due to other causes cannot be altogether excluded.

Further, if the figures are accepted as correct in those cases in which careful records have been kept, we have not the means of applying them to other towns. The extent of illness properly ascribable to shell-fish would depend partly, on the proportion of the population who were consumers of shell-fish, and on the degree of contamination of the shell-fish supplied to the particular town.

There can, however, be no doubt that the evil is sufficiently grave to demand a remedy.

NEED OF SOME MEASURES.

30. This indeed has already been admitted by the Government. In 1899 they introduced a Bill for the protection of public health against dangers arising from the consumption of unwholesome oysters.

As the Bill was originally drawn, the local authorities were to be the councils of every county and every borough. The House of Lords Committee, to whom the Bill was referred, substituted the Sea Fisheries District Committees. The Bill was then abandoned.

31. Several witnesses representing the trade as well as local authorities, have urged upon us the necessity of measures being taken to prevent the sale, for human consumption, of shell-fish which have become contaminated by sewage.

Anderson, 16045 *et seq.*; Petrie, 16275–7; Bean, 17311; Nash, 17188; Newsholme, 17572; Niven, 17845; Williams, 18795; Murphy, 18862; 19017.

Anderson, 16204-10. Bean, 17311; 17330. Although in this relation the interests of public health have first to be considered, the evidence shows that legislation is desirable in the interests of the industry also.

Captain Anderson, the Chairman of the Whitstable Company, estimated the capital value of the shell-fish industry round the coast at from £6,000,000 to £8,000,000, and from the evidence of several witnesses it is clear that a large number of men are employed in the industry. Any great disturbance in an industry of such magnitude is in itself an evil, and the public accounts of disease and death being due to eating shell-fish have brought about a great disturbance to the trade.

Shell-fish.
Anderson, 16030-4
Dawson, 16320.
Donnison, 16434.
Gibson, 16564.
Kennett, 16903.
Bean, 17311.
Blamey, 17520-36.

In consequence of "Oyster scares" the diminution in the consumption of shell-fish has been serious and many men have been thrown out of employment.

Anderson, 16135.
Scott, 16822-3.
Brazier, 16859-63
Pink, 16956.
Bean, 17311-3

REMEDIES SUGGESTED.

Shell-fish.

32. The remedies suggested may be divided into three general classes :—

(1) Purification of the sewage before its discharge into tidal waters.

(2) Seizure and destruction of unwholesome shell-fish exposed for sale.

(3) The setting up of a competent authority to deal with all tidal waters, with power to control foreshores, to close dangerous beds, pits, ponds and layings, and in certain circumstances to require treatment of sewage.

PURIFICATION OF SEWAGE.

33. It has been suggested that the evils would be removed if the law were altered so as to require that all sewage should be purified before its discharge into tidal waters. We do not consider that any such sweeping alteration of the law could be justified.

There are undoubtedly many cases, where shell-fish are not concerned, in which the discharge of crude sewage into such waters, does not, according to present knowledge, cause any harm, and to require purification in all cases would lead to the waste of large sums of money.

And even where shell-fish have to be considered, such an alteration of the law would not always meet the necessities of the case.

Paragraph 21.

34. In our Interim Report, dated the 12th July, 1901, we pointed out that effluents from sewage farms as well as effluents from artificial purification processes usually contain large numbers of micro-organisms, many of which appear to be of intestinal derivation.

Since that time we have examined many more effluents of both classes, but we have seen no reason to alter our opinion that such effluents must be regarded as potentially dangerous, inasmuch as they may still contain disease-organisms.

We would particularly refer to the experiments which Dr. Houston has made with B. pyocyaneus (microbe of green pus). Dr. Houston's report is printed in full in the Appendix, (Vol. III.)

It will be seen that this micro-organism, which was added to the sewage in large numbers, passed freely through sewage purification works, consisting of:—

(*a*) Septic tank and contact bed.

(*b*) Continuous filter about ten feet in depth.

With the advance of knowledge it is possible that some method of sewage treatment may be devised by which, within reasonable limits of cost, the dangerous qualities of the sewage may be wholly eliminated, but the treatment of sewage, according to methods at present in use, cannot be relied on so to alter its character as to allow of its discharge in the immediate neighbourhood of shell-fish layings, without incurring appreciable risk of disease being communicated by the consumption of shell-fish taken from such layings. In such cases either the sewage outfall must be removed or the layings closed.

35. In other cases where (*e.g.*) the layings are at a considerable distance from the outfall and the sewage would be largely diluted before it reached them, treatment of the sewage might be of value in diminishing risk.

Careful and skilled examination of the local conditions would, however, be necessary to distinguish such cases, and it is not possible by enactment to lay down any general rule as to the cases in which treatment of the sewage should be required, or as to the kind of treatment which should be adopted before the effluent is allowed to flow into tidal waters.

SEIZURE OF UNWHOLESOME SHELL-FISH.

Newsholme,
17538.

36. The proposal that the sale of contaminated shell-fish might be prevented by proceedings under Section 116 *et seq.* of the Public Health Act, 1875, was brought to our notice by Dr. Newsholme.

Under these provisions any medical officer of health or inspector of nuisances may inspect and examine various articles of food (including fish), and if they appear to him to be unfit for the food of man he may seize them and apply to a Justice of the Peace for an Order for their destruction.

37. The suggestion that these provisions might suffice was made to the Corporation of Brighton by the Local Government Board, but we are bound to say that we agree with Dr. Newsholme in thinking that the provisions are practically useless for preventing the sale of contaminated shell-fish. *Shell-fish.* Newsholme, 17538. Williams, 18794.

There is nothing in their appearance to distinguish shell-fish which have been exposed to sewage contamination from those which have not been so exposed, and, as we shall explain later, in the present state of knowledge it would not be practicable to make the distinction by the aid of a bacteriological examination as a routine measure.

38. In our opinion no general enactment as to the treatment of sewage or as to the seizure of unwholesome food would meet the necessities of the case: the remedy must be sought in connection with the waters, foreshores, pits, ponds and layings themselves.

REMEDY RECOMMENDED: CONTROL OF WATERS AND PITS, PONDS, LAYINGS AND BEDS.

39. After carefully considering the whole of the evidence, together with the results of our own investigations and local inquiries, we are strongly of opinion that the only way in which this evil can be effectively dealt with is by placing tidal waters under the jurisdiction of some competent authority, and conferring on that authority power to prevent the taking of shell-fish for human consumption from any position in which they are liable to risk of dangerous contamination, and to enforce restrictions as regards pollution, and as regards waters, foreshores, pits, ponds, beds and layings in which shell-fish are fattened or stored, as and when required.

For this purpose the powers of the authority must be elastic. The case of each river and estuary is a problem by itself, and it would not be practicable to fix by enactment any standard or standards which would be generally suitable to the widely different conditions of different cases. Moreover, as the conditions are shifting in character, it is necessary to provide some permanent machinery by which restrictions can be varied. Herdman, 18196. Bulstrode, 15718 *et seq.*

Shell-fish.

CONTROLLING AUTHORITY.

Anderson, 16074-82.
Baxter, 17011.
Nash, 17223-32.
Bean, 17332-8.

40. Some witnesses have expressed the view that the control required should be solely in the hands of a central authority, but we are not able to adopt this suggestion.

It appears to us that in this matter local power can be utilised with advantage, and therefore should be used, and that the central authority should usually act as a court of appeal only.

It is important to provide for appeal from the decision of the first tribunal, but this could not be done satisfactorily if the initial control were vested in a Government Department.

CONTROL SUGGESTED IN OYSTER BILL.

41. Under the Oyster Bill of 1899 it was proposed that the Local Government Board should be the central authority, and that the local authorities should be the Councils of every County and every Borough. To these local authorities strong objection was taken before the House of Lords Committee by the witnesses representing the Fishing Industry. It was considered that they would not be impartial and it was obvious that the Oyster Merchants would not have had confidence in their decisions.

As a result of this opposition the Lords Committee substituted the Sea Fisheries District Committees.

Anderson, 16150-3
Petrie, 16253-5.
Bean, 17338.

Our evidence shows that notwithstanding the fact that people engaged in the trade are now desirous that restrictions should be enforced, they would still strongly oppose placing the powers in the hands of the County and Borough Councils.

Thresh, 18029-31.

The fear has been expressed that even with so large an area as the County local interests might not always be eliminated; and we may also observe that in the matter of sewage disposal the Borough Councils would frequently be the Councils to whom restrictions would have to be applied.

In our opinion it is most important that the local authorities should command the confidence alike of sewage authorities and of the fishery trade, otherwise appeals and delays would be endless. This would not be secured if the control were vested in the County and Borough Councils and we cannot therefore recommend that the local authorities should be those proposed under the Oyster Bill as originally drawn.

SEA FISHERIES COMMITTEES.

42. Neither do we consider that the local authority substituted by the House of Lords Committee could properly be accepted. Indeed, in some respects, this amendment is open to more serious objection than the original Bill.

Dawson, 16371.
Donnison, 16499-500.
Gibson, 16572-4.
Gibson, 16643.
Pink, 16961.
Herdman, 18232-4

We fully realize that the Fisheries Committees have done excellent work, but they are in no sense sanitary bodies, yet the control which we are discussing is essentially a sanitary matter, involving at times sanitary questions of great complexity and difficulty. Moreover, their organization and constitution are not such as are required for the exercise of the control which is needed. Further, their interests are in the main bound up with the industry, and the matters to be dealt with would frequently involve decisions on questions in which these interests and those of the public health would come into conflict. For these reasons we think it would be unwise to place the local control in their hands.

RIVERS BOARDS.

Nash, 17304-7.
Newsholme, 17573-5.
Niven, 17847-62.
Thresh, 18036.
Murphy, 18862-3.

43. The witnesses representing local authorities are generally in agreement in thinking that the necessary control could best be exercised through the machinery of large Rivers Boards and a Central Authority, which we recommended in our Third Report, and there is reason to think that these bodies would generally command the confidence of the Trade.

Mr. Wrench-Towse, the Clerk to the Fishmongers Company, stated that "the recommendation is as good as I have heard or could suggest," (19669).

44. As regards these bodies the following extracts from the Report of the Salmon Fisheries Commission are of interest :— *Shell-fish.*

Page 12.

" We think that in any event there ought to be a Board capable of dealing with the fisheries " of an entire watershed. The Royal Commission on Sewage Disposal has announced its " adherence to this principle in the matter of the pollution of rivers, and it will be seen below " that we concur in that opinion. If workable Boards can be formed for so delicate and " complicated a work as the purification of rivers, and the experience of the West Riding and of " Lancashire is entirely favourable, we see no reason why the administration of the fisheries " should not be satisfactorily reformed in like manner, if not actually on the same lines.

* * * * * * * *

" There are three great subjects, for all of which, in our opinion, the Watershed is the proper " administrative area, *i.e.*, Pollution, Water Supplies, and Fisheries. If it were possible to give " adequate representation to all the interests concerned in one body, we should have a Board " of great influence, capable of interfering authoritatively in any matter affecting the district, " while, by the formation of separate Committees, the administration of each of the subjects " above-named might be left in the hands of representatives best qualified to carry it on."

Page 46.

" The Commissioners (Sewage) in their Interim Report, dated July 12th, 1901, have dealt " with the question of 'what means should be adopted for securing the better protection of our " rivers,' and have recommended a single authority for each watershed under a Supreme Rivers " Authority. This recommendation we unhesitatingly adopt and cordially support, and, on " page 12, we have suggested that the same authority might administer Fishery matters in " England and Wales."

Shell-fish.

NATURE OF CONTROLLING MACHINERY.

45. The machinery to which reference is made was recommended by us as being necessary for the settlement of disputes between manufacturers and local authorities as regards trade effluents and for the prevention of pollution and the protection of water supplies. Its nature will be gathered from the following extracts from our Third Report :—

Paragraph 44. " In our opinion a properly equipped Central Authority is essential, and we unhesitatingly " recommend the creation of such an Authority.

* * * * * * * *

Paragraph 45. " The Central Authority should have the following permanent chief officers :—

1. " An Administrative Head.
2. " A Bacteriologist having special knowledge of the bacteriology of sewage, trade effluents, and water supply.
3. " A Chemist having special knowledge of the chemistry of sewage, trade effluents and water supply.
4. " An Engineer having a special knowledge of geology and water supply.

" It should also be provided with a laboratory.

* * * * * * * *

Paragraph 48. " The work of the Central Authority will be so intimately connected with the work of the " Local Government Board that it will be desirable to make it a new department under the " Local Government Board rather than an entirely separate department.

* * * * * * * *

Paragraph 60. " At an early stage of our investigation we were struck by the fact that in many parts of " England the pollution of rivers goes on unchecked, notwithstanding the fact that the " Rivers Pollution Prevention Act has been on the Statute Book for over a quarter of a century, " and in our Interim Report we deemed it necessary to state that the protection of our rivers " is a matter of such grave concern as to demand the creation of a Supreme Rivers Authority.

" Since the issue of this Report we have been requested by the President of the Local " Government Board to make a recommendation dealing with the whole subject of water " pollution.

Paragraph 61 " The Central Authority, which we have recommended should be set up for the determination " of differences between the local authorities and the manufacturers, should deal also with this " matter. For this purpose it will be desirable to add an Epidemiologist to the staff of the " Central Authority.

" We do not, however, consider that the Central Authority should take the place of local " bodies in regard to the protection of rivers and other sources of water supply. On the " contrary, we think local power should be utilised to the fullest extent possible.

Paragraph 62. " In our opinion such power can only be fully utilised by the formation of Rivers Boards " throughout the country, and we therefore recommend that such Boards should be formed.

Paragraph 63. " Although the Rivers Boards are merely joint Committees of County Councils and therefore " only possess for the combined areas the same powers which the individual Councils might have " exercised in their respective districts, we are satisfied that such combinations are of much " greater value for the protection of rivers and streams than the separate Councils acting " independently.

Paragraph 64. " In the first place, they are bodies expressly created for enforcing the provisions of the " Rivers Pollution Prevention Act, whereas the separate County Council is under no obligation " to enforce these provisions. And we find as a fact that in many counties outside the areas " represented by the existing Rivers Boards little or nothing is done by the County Council to " exercise its powers of checking river pollution.

Paragraph 65. " Then, too, a Rivers Board has jurisdiction over practically the whole of a watershed. " This is a point of considerable importance.

" It has been again and again pointed out by previous Commissions that to obtain effective " action there should be some one authority with power to deal in each instance with the whole " watershed, and we entirely concur in this view.

Paragraph 66. " Another advantage of combination is that the area under the jurisdiction of a Rivers " Board is sufficiently large to secure the appointment of skilled officers.

Paragraph 67. " We have not sufficient information to enable us to say what precise combinations should " be made. Each Rivers Board district should, however, include, as far as practicable, the " whole of one or more watersheds, and it should be sufficiently large to justify the permanent " appointment of a skilled Chief Inspector at an adequate salary.

" One of the first duties of the Central Authority will be to ascertain what grouping of " counties would be most effective, and then to take steps to constitute Rivers Boards for these " areas.

* * * * * * * *

> "The Central Authority should exercise a general superintendence over the whole country "in regard to the prevention of pollution of water. They should direct any inquiries or "investigations which they may consider desirable, and generally they should stimulate and "encourage Rivers Boards to an active exercise of their powers."

Shell-fish.

Paragraph 70

RECOMMENDATION.

46. We entirely agree with the view which has been pressed upon us by a large number of witnesses that Rivers Boards would be the most suitable bodies in whom to vest the local control which we are now discussing. Their control over inland waters is of a similar character to the control which is required over tidal waters *(estuarial and other)*, and it is desirable and fitting that their jurisdiction should be extended to tidal waters for public health purposes. There are indeed no other local bodies possessing the necessary qualifications, and the only practicable alternative to giving them jurisdiction would seem to be to place the whole control in the hands of a Central Department. To this course we have already indicated our objections.

47. We therefore strongly recommend that the necessary power of control over the pollution of tidal waters and over waters, foreshores, pits, ponds, beds, and layings where shell-fish are grown, fattened or stored, should be vested in the Rivers Boards, subject to appeal to a Central Authority. In the next section of this report we shall explain the general method of procedure which should be adopted.

No provision is made in the Irish Local Government Act, 1898, for constituting Rivers Boards. In any Act dealing with this question, special provision will therefore be required for providing such Boards in Ireland.

48. In the case of Rivers Boards having tidal waters under their jurisdiction, we think it would be desirable that the Fisheries Committee should be empowered to appoint one or more representatives.

When setting up these Boards it might also be considered whether it would not be practicable to transfer to them the powers of Salmon Conservators and other similar bodies. We have not sufficient information to justify us in making any precise recommendation on this point, but we gather from the Report of the Royal Commission on Salmon Fisheries, to which we have already referred, that they were in favour of such a transfer of powers.

49. As regards the Central Authority we have little to add to what we have stated in our Third Report. It is clear from our researches in regard to the contamination of shell-fish, that there is still much scientific work to be done and information to be collected before the dimensions of the danger thus arising can be accurately stated; but we think that the major portion of the evils can be removed by the setting up and exercise of the control which we have recommended, and that we should not be justified in delaying this Report, pending the result of further investigations.

Indeed, much of the work necessary should be further carried on for a considerable period, and it would more properly fall to a permanent department than to a temporary commission. It is desirable therefore to emphasize the fact that this department must be well equipped for carrying on the necessary scientific work as part of its regular duties.

Shell-fish.

PROCEDURE TO BE ADOPTED BY CONTROLLING AUTHORITY.

50. We do not propose to draft the measure required to carry out our recommendations, but we think it may be useful if we indicate the nature and scope of the main provisions which, as a result of our consideration of the evidence and our local investigations, appear to us to be necessary.

SURVEY OF DISTRICTS.

51. Having appointed competent officers, the first duty of each Rivers Board would be to make a careful survey of all tidal waters within their jurisdiction.

Maps should be prepared shewing all sewers, drains or other sources of pollution, and all foreshores, beds, layings, ponds, ledges, floats or other places where shell-fish are bred, grown, fattened or stored.

Information should be compiled as to the nature and quantity of the polluting liquids discharged, as to the volume of tidal waters with which these would be mixed at various states of the tide, as to the set of currents, and generally as to all topographical conditions affecting the question of pollution.

PROHIBITION OF AREAS AND REGISTRATION OF PITS, PONDS, BEDS, LAYINGS, &c.

52. The Act giving effect to our recommendations should provide that the Rivers Board should register, for a definite or for an indefinite period, and subject to revocation or suspension, as we shall explain later, all beds, layings, ponds, pits or other storage places from which, in their opinion, shell-fish may properly be taken for human consumption.

As regards foreshores and waters which are not owned by private persons, and from which shell-fish are taken, registration would not be suitable. In these cases the Rivers Board should define the areas from or within which, in their opinion, shell-fish may not safely be taken for human consumption.

It should be provided that all sale of shell-fish for human consumption from places not so registered, or from prohibited areas of foreshore or waters, should be illegal; and, further, that all shell-fish about to be placed on the market shall not, within a period of six weeks immediately preceding offer for sale for human consumption, have been gathered from an unregistered bed, laying, pond, pit or other storage place, or from a prohibited area. This is intended to apply to home-grown shell-fish.

Anderson, 16036-7. Petrie, 16217; 16223-5. Baxter, 17019-35. Niven, 17844, Barber, 18403.

Large numbers of foreign shell-fish which are imported into this country are put direct on the market. With these we deal in a later part of this Report. It is, however, necessary to provide for those foreign shell-fish which, for convenience of sale, are stored for a variable period in our waters. Layings, &c., intended for the temporary deposit of these foreign shell-fish, and from which the shell-fish will be taken direct for human consumption, should, we think, be registered separately. Subject to the condition recommended by us in regard to foreign shell-fish, in paragraph 101 of this Report, the above provision as to the period of deposit need not apply to such shell-fish, unless after arrival they have been for a time previously stored in an unregistered place. Shell-fish which are imported young, and which will not come on the market for two or more years should be regarded as home-grown for the purpose of registration.

53. The registrations of beds, layings, &c., should depend on the report of the Inspecting Officer of the Rivers Board.

In any case where he reports against registration, a copy of his report should be sent to the owner or occupier, who should have a right within a specified period to lodge an appeal with the Rivers Board against the adoption of the report. If an appeal is lodged, the Rivers Board should appoint a Committee of three or more of its members to hear the appellant.

Having received this report, together with any other information which they may think it necessary to obtain, the Rivers Board should decide whether the laying; &c., should be registered or not. *Shell-fish.*

We think it a matter of importance that objectors should have a full opportunity of being heard before a decision is arrived at.

Similar procedure should be followed in the case of foreshores and waters not the subject of private ownership. In such cases the Fisheries Committee might be given a right of appeal against prohibition.

54. It would also be desirable to provide that any local authority having reason to consider that any registered bed, laying or other place, or any area not subject to prohibition, whether within or without their district, is not free from liability to dangerous contamination, should be empowered to represent the matter to the Rivers Board. Any such representation should be dealt with by the Rivers Board in a similar way to that recommended above in the case of applications for registration. Newsholme. 17575 *et seq.*

TEMPORARY CLOSING OF FORESHORES, BEDS, LAYINGS, PONDS, &c.

55. Provision must also be made for the temporary closing of defined areas of foreshores or waters, layings, &c., in the event of special dangers arising, and we consider that it should be the duty of the Medical Officer of Health of any district concerned to report to the Rivers Board any circumstances, such as outbreaks of infectious disease, failure or alterations of Sewage works, which he may consider increase the liability of dangerous contamination of shell-fish in the waters under the jurisdiction of the Rivers Board. Similar powers to report should also be conferred on the Fisheries Committee. If, on investigation, the Rivers Board should consider that dangerous conditions have arisen, they should have power forthwith to suspend temporarily registration of any layings, &c., or to prohibit the taking of shell-fish for human consumption from particular areas of foreshore or water. Until the suspension or prohibition is removed it should be illegal to take shell-fish for human consumption from the layings, &c., to which the suspension or prohibition applies. Herdman, 18,265-70.

Although we think it desirable that these express powers of representation should be conferred on the local Medical Officers of Health and on the Fisheries Committee, the Rivers Boards should, of course, be free to take action on their own initiative, and it must be clearly understood that we contemplate that the responsibility for securing that shell-fish are not taken for human consumption from any dangerous places would rest with them.

APPEAL TO CENTRAL AUTHORITY.

56. In all the foregoing cases provision should be made for appeal to the Central Authority, whose decision should be final. In the case of the temporary suspension of registration or temporary prohibition of areas in consequence of temporary dangers, the layings, &c., should be closed pending the result of the appeal.

TREATMENT OF SEWAGE IN CERTAIN CASES.

57. In an earlier section of this report we have pointed out that in some cases treatment of the sewage should be required before its discharge into tidal waters. It should rest, in the first instance, with the Rivers Board to decide these cases. The procedure should, we think, be as follows.

It should be the duty of the Chief Inspector of the Rivers Board to report to the Rivers Board, from time to time, any cases in which he considers treatment should be required, together with his reasons for such opinion.

If, on receipt of such report, the Rivers Board should be satisfied that a *prima facie* case for treatment has been made out they should forward a

Shell-fish.

copy of the report to the local authority concerned, and if the local authority object to the adoption of the report they should have a right within a specified period to lodge an appeal with the Rivers Board.

The Rivers Board should then appoint a committee of three or more of its members to hear the appellant, and if, after due investigation, they are satisfied that treatment of the sewage is reasonable and desirable, having regard to all the circumstances, they should make an order requiring the local authority to provide treatment of the sewage.

If no appeal is made, the Rivers Board should be empowered to make an Order without further investigation than that which was made by their Chief Inspector before making his report.

All orders requiring a local authority to adopt treatment of sewage should be subject to confirmation by the Central Authority.

Provision should also be made for control over discharges from private drains.

NEW OUTFALLS.

58. The consent of the Rivers Board should be required to the construction of any new sewage outfall, or drain into tidal waters.

Provision should be made for appeal to the Central Authority, whose decision should be final.

This recommendation is not intended to interfere with the present powers of the Board of Trade as to navigation and as owners of the foreshore. The matter is more fully dealt with in the next section of this Report.

DIVIDED JURISDICTION.

Pelham, 8791, *et. seq.*

59. It appears from the evidence of the Hon. T. H. W. Pelham, Assistant Secretary to the Board of Trade, that the sanction of that Department is required to the construction of sewers or other works below high water mark. This control is vested in that Department as owners of the foreshore and in the interests of navigation, but it has been used indirectly for the purpose of preventing the discharge of sewage into tidal waters.

Pelham, 8769.

60. Mr. Pelham informed us that it was the practice of the Board of Trade to ascertain the views of the Fisheries Committee before coming to a decision on applications for consent to the construction of a sewage outfall, and he stated that the Board of Trade had in several instances refused their consent.

In some cases the grounds of refusal appear to have been that the Fisheries Committee considered that the sewage would possibly render the shell-fish from certain layings in the neighbourhood of the outfall liable to rejection as human food.

Considerations such as these ought, of course, to have weight, but we are of opinion that the Rivers Boards and the Local Government Board are the proper authorities to deal with them, and that the practice of the Board of Trade might lead to an undesirable conflict of jurisdiction.

Pelham, 8769.

61. For the reasons we have already given, we do not consider that the Fisheries Committee is a suitable body to decide such questions, and Mr. Pelham himself admitted that the Board of Trade have no evidence to offer "as to the effect of crude or other sewage on different kinds of fish, or as to what degree of purification is necessary to render sewage innocuous."

On the other hand, the Rivers Boards and the Local Government Board would have skilled advice on these matters, and, therefore, we should suggest that the Board of Trade, in giving or withholding consent should not entertain representations and considerations respecting fisheries such as have governed their decisions heretofore.

WHAT FORESHORES, WATERS, BEDS, LAYINGS OR PONDS SHOULD BE CLOSED.

Shell-fish.

62. In the next section of this report we shall deal with the subject of bacteriology as applied to the examination of tidal waters and shell-fish, but in considering the question what layings or ponds should be closed, it is necessary to point out at once, that the results of the bacteriological examination of chance samples from layings or ponds obviously exposed to gross contamination, has not invariably indicated that their position was objectionable in the sense of dangerous.

In this connection, we may refer to the experiments which were made by Dr. Klein for the Local Government Board in connection with Dr. Bulstrode's inquiry on Oyster Culture in relation to disease. From these it will be seen that in more than one instance bacillus coli, which had been taken as the index of pollution, was not detected in the interior of oysters which had been exposed in high degree to sewage contamination.

C. 8,214 896).

63. The following is an extract from Dr. Klein's Report, printed on pages 113 and 114 of Report (C. 8214, 1896) of the Medical Officer of the Local Government Board for 1894-95 :—

Examination I.—" Two batches of oysters, Nos. 1 and 2, were received from Dr. Bulstrode.

" (All the oysters in question were dredged up by me from an estuary in which the oyster " layings must needs be exposed in high degree to sewage contamination. Certain of these " oysters, indeed, were procured in situations very near to sewage outfalls.—H. T. B.).

" From the exterior of the shells of samples from both batches of oysters, abundance of bacilli " were obtained by the phenol broth process. Some of these bacilli, more particularly from the " outside of oysters of batch No. 1, proved on subculture to be typical bacillus coli; others, from " the outside of oysters belonging in the main to batch No. 2, corresponded in all respects with " this micro-organism, save for the circumstance that they did not produce gas bubbles in " gelatine shake culture. From the interior of none of these oysters was bacillus coli obtainable.

Examination II.—" Three batches of oysters, Nos. 3, 4 and 5, were received from Dr. Bulstrode.

" (The oysters of batch No. 3, were from a " market-pit " on the foreshore of a creek within " the precincts of a small town, situated near to the outfalls of several sewers. Those of batches " Nos. 4 and 5 were from " oyster ponds," on the shore of a narrow tidal river, placed close to " drain outlets from a large village.—H. T. B.).

" As regards one oyster only (batch No. 5) from the three batches, did material from the " outside of the shell yield bacteria that could be identified as bacillus coli; while from the " interior of none of the oysters, though several of each batch were duly examined, could the " above bacillus or the bacillus of typhoid fever be obtained by the culture methods adopted.

" *Experiment III.*—Four batches of oysters, numbered respectively 6, 7, 8 and 9, were received " from Dr. Bulstrode.

" (The oysters of batches No. 6 and 7 were from ' market beds ' in the seaward portion of an " East coast estuary; those of batches Nos. 8 and 9 were from ' storage pits ' on the foreshore " of the same estuary, but within the limits of a small town.—H. T. B.)

" Upon the exterior of one only of these oysters (from batch No. 9) was bacillus coli " discoverable. As regards their interior, the result was also negative, except in a single " instance; from one oyster only (batch No. 7) was bacillus coli obtained, though in this instance " the microbe was present in abundance within the shells.

" *Experiment IV.*—Two batches of oysters, numbered 10 and 11, were received from " Dr. Bulstrode.

" (Both batches were from the same estuary as those of Experiment III., but from oyster " grounds less far removed from shore influences.—H. T. B.)

" Upon no oyster from either batch was bacillus coli discoverable, and within only one of " them could this microbe be detected. In this particular instance, however, it was present in " abundance.

" *Experiment V.*—Three batches of oysters, Nos. 12, 13, and 14, were received from Dr. " Bulstrode.

" (Batch No. 12 was from a ' storage pond ' on the South coast of England, so placed on the " foreshore below high water mark as to be open to contamination with sewage matters from drains " discharging on the beach at no great distance. Batch No. 13 was taken from a sack of oysters " recently received in the same locality from ' layings ' on the East coast. Batch No. 14 was " from a ' storage pond ' situated on the same beach as that from which Batch No. 12 was " taken, but far more obviously exposed than the other to sewage contamination.—H. T. B.)

" Not a single oyster from any one of these three batches yielded from its exterior or from its " interior any microbe identifiable with bacillus coli.

" *Experiment VI.*—Three batches of oysters, Nos. 15, 16, and 17, were received from " Dr. Bulstrode.

" (All three batches were from ' storage ponds ' situated near to (and inclusive of) that from " which Batch No. 12 of Experiment V. had been obtained.—H. T. B.)

"Of these three batches every oyster examined yielded from its interior bacillus coli in "considerable amount. None of them were tested as to the presence of this microbe on their "exterior.

"*Experiment VII.*—Three batches of oysters, labelled respectively 'Natives' 'Portuguese, "and 'Deep-sea' were received through Dr. Bulstrode.

("All three batches were from an estuary in the West of England which receives much crude "sewage.—H. T. B.)

"From no oyster of any one batch was bacillus coli obtained. None of them were examined "as to microbes on the exterior of their shells.

"*Experiment VIII.*—Two batches of oysters Nos. 18 and 19, were received from Dr. Bulstrode.

("Both batches were from 'oyster layings' below low-water mark in an estuary on the East "coast, but so situated as to be under strong suspicion of contamination by sewage discharged in "abundance into the estuary within a mile or two of the spot at which the oysters had been "'laid down.'—H. T. B.)

"From the interior of oysters from both batches bacillus coli was obtained in abundance; also "in some of them the variety of proteus Zenkeri that I have referred to. None were examined "as to microbes on their exterior."

McWeeney, 19484, *et seq.*

64. Since the time when these experiments were conducted, a great deal of further work has been done. We may refer particularly to the valuable bacteriological work which Professor McWeeney has done for the Irish Local Government Board, and to especially painstaking and even more extensive work which Dr. Houston has done under our direction. Without going into the details of this work, we may at once say that in our opinion we should not be justified in recommending that the closing of a foreshore laying or pond should depend, *as a matter of routine*, on the results of a bacteriological examination.

Nash, 17170.
Blamey, 17446-51.
Newsholme, 17542
Thresh, 18025.
Williams, 18794.
Bulstrode, 19722, *et seq.*

65. It will be seen from the evidence of Dr. Bulstrode and others, that in the great majority of the cases in which outbreaks of disease have been clearly traced to shell-fish, the foreshores layings or ponds from which the shell-fish have been procured have been so situated that the opportunities of pollution by sewage have been obvious and indisputable. That is to say, the foreshores layings or ponds in question were such as would have been condemned on a careful examination by a trained person without the aid of bacteriological examination of the water or the shell-fish.

Having regard to the number of such foreshores layings and ponds obviously liable to pollution which Dr. Bulstrode has noted in England and Wales, and Dr. Browne in Ireland, we think that in the light of experience we are justified in concluding that, *if those were closed, or else freed from chance of pollution, the greater number of cases of disease due to the consumption of contaminated shell-fish would be eliminated.*

66. At the same time we wish to point out that it is not at present possible to define with certainty the limits to which dangers due to the discharge of sewage into a tidal river or estuary may extend. Numerous analyses which we have had made of samples of the purest waters in which native oysters are fattened, have shown that B. coli or coli-like microbes may not uncommonly be detected in 10 c.c., and sometimes in 1 c.c. of such waters. The same is also true of the oysters themselves. Judged by this test such waters might be considered not wholly free from objection for the purpose of shell-fish layings. There is, however, no evidence to show that shell-fish obtained from layings such as these have caused outbreaks of disease, and in considering the administrative aspects of this question, this is a fact to which we attach great weight.

It is a serious matter to close an oyster laying, and it might involve those engaged in the industry in considerable loss. The step therefore, ought not to be taken merely for reasons which are at present more or less theoretical; there ought to be adequate evidence that the laying is really a source of danger to health.

67. In our opinion the first step should be to deal with those foreshores, pits, ponds, beds or layings of which the pollution is obvious and indisputable. Action in regard to the more doubtful cases should be deferred until more complete and exact knowledge has been obtained.

The matter is well put in the evidence of Mr. Shirley Murphy, the Medical Officer of Health for the County of London, from which the following extracts are taken:—

"19,008. (Mr. Stafford): In reply to General Carey, who asked you about layings being "properly dealt with, would you tell us what you would consider properly dealing with a laying as "regards sewage contamination?—I should examine particularly the physical circumstances "with regard to shell-fish layings, their proximity to sewer outfalls, the direction of currents, "and so on, and I should also wish to have regard to such evidence of pollution as the bacteri- "ologist and perhaps the chemist may afford; but very much in the main I should be guided "by the physical circumstances, and certainly where there is evidence of pollution, such as may "be found in Dr. Bulstrode's report, I should be perfectly satisfied, that the sale of shell-fish from "such layings ought to be prohibited." *Shell-fish.*

"19009. Yes. Those are the grosser cases?—Those are the grosser cases."

"19010. There will probably be some difficulty with regard to less gross cases. Would you "lay down any bacteriological or chemical standard of purity?—I do not think I should at once; "whether we may come to that later, I am not at all prepared to say, but at any rate to begin "with, I should not. It seems to me that if these River Boards got to work, and brought to an "end the existence of the obviously-polluted layings, they would in the meantime, by studying "the subject, have got further knowledge that might be applied perhaps to those that are less "polluted. The thing would have to be done by degrees, though some of the layings, I take it, "would at once go. With regard to others, it would be a matter for doubt as to how to "proceed."

"19011. Would you let me put you a concrete case in regard to this map? Suppose that you "had no pollution at Southend or Leigh, that you had merely to deal with the effluent from Barking "and Crossness, do you think that you could lay oysters safely about Leigh and Southend?—I "should not be prepared, with the knowledge I have, to say it was impossible to lay them there.

"19012. Now what standard would you ask for there? Would it be a bacteriological standard? "You know the composition of the effluent from Barking and Crossness, and what standard of "purity would you require for laying oysters at Southend and Leigh?—Well I do not think I "should have a standard of purity for that. I went to Leigh, I saw the outfall from the sewage "works in such close proximity to the layings of cockles, I had no difficulty about that.

"19013. I am assuming that Leigh and Southend are treating their sewage perfectly, and I am "dealing altogether with the effluent coming from Barking and Crossness. Would you under "those circumstances, assuming there was no other pollution, consider that oysters might be laid "at Leigh and Southend?—With such knowledge as I have at the present time I should not "object to it.

"19014. Quite so; but what standard, then, would you adopt? You would require some "standard; from topography, from inspection, it seems all right; you would require some "bacteriological standard or chemical standard?—I think you must ask the bacteriologists upon "that point. I personally should hesitate very much to apply a standard there without knowing "exactly what the effects of it are going to be as applied to England generally. I take it that if "you apply a high standard you will practically prohibit the laying of shell-fish in any way "round the English coast.

"19015. Yes, but that is eminently a case for a bacteriological or chemical standard?— "Yes, if you can show that alongside with bacteriological and chemical standard you can get "some clinical evidence of mischief arising from it.

"19016. You would wait for some further evidence?—Yes; as I say, I do not profess to speak "as a bacteriologist, but I do say this—that I should, at any rate in the earlier stages of any "administration, propose to have regard rather to topographical circumstances than to any "standard that could be given in that way.

"19017. I asked you the question because I see here in your statement that the London "County Council have been pressed by various bodies—the Sanitary Institute and 21 Metropolitan "Borough Councils—to promote legislation with regard to this question of layings of shell-fish, and "you addressed a letter to the Local Government Board—the County Council did—"expressing "the Council's hope that in the interests of the public health the Board will, as soon as possible, "take steps to obtain an amendment of the law, so as to prohibit under heavy penalties, the "laying down of all edible forms of shell fish in sewage-polluted creeks or other dangerous "localities." The "other dangerous localities" and the "sewage polluted creeks," one wants to "get some fixed idea of how much pollution. What is the standard of pollution?—I think "that the proposed Central Board must study the subject very much further than it has yet been "studied before it would be possible to arrive at anything like a standard of pollution that should "determine the position of shell-fish layings. I do not think that such a standard can now be "stated, but what can be done, and what I feel sure ought to be done, is the closure of such layings "as have been specially pointed out in Dr. Bulstrode's report.

"19018. So it is not quite so easy a matter as they seem to think to legislate with regard to "all these questions of pollution and dangerous localities?—No doubt the layings that are on the "border line would raise very difficult questions.

"19019. I allow you, of course, a certain number would go out at once probably, but there "would be very considerable difficulty of administration with regard to a great number of layings? "—I think there will be difficulties of administration with regard to it, but that is a matter that "must be made the subject of very careful investigation by the Central Board, and one hopes "that knowledge will increase sufficiently to enable questions of that sort to be determined.

"19020. You would wait before attempting to lay anything down in the shape of standards?— "I should myself."

Shell fish.

BACTERIOLOGY AS APPLIED TO THE EXAMINATION OF SEA WATER AND SHELL-FISH.

68. It will be seen from the evidence of Dr. Klein (17,663 *et seq.*) that his test for oysters was based on the view that "the normal oyster does not harbour within its shell or within its body bacillus coli communis or other B. coli closely allied to it." He arrived at this conclusion, "from a considerable number of examinations of oysters, taken either from layings in deep waters or from localities to which no sewage or filth has access."

Starting from this premise he inferred that the "presence" of B. coli communis, "in considerable numbers of oysters in a series of samples from a particular locality, may be taken to indicate sewage pollution."

On cross-examination, Dr. Klein further explained his position, as the following extract from his evidence will show :—

> "Q. 17,836 (Col. Harding): Am I right in understanding that you think, in subjecting "oysters for bacteriological investigations, we are to be guided rather by the proportion of "the oysters that are contaminated at all, and not so much by the amount of the "contamination in a particular oyster ?"
>
> "A. That is so, because it is liable to constant alteration. As regards sewage contamination "in water, you ought to take into account, not the absolute, but the relative amount."

69. As regards the application of bacteriology to the shell-fish problem, Dr. Bulstrode strongly urged upon us, at an early stage of our inquiry, 15,716. the importance of ascertaining the distribution of the bacillus coli in nature. He seemed to think that it was possible that the information obtained on this point might invalidate the inferences with regard to sewage pollution which were based solely on figures obtained from a bacteriological analysis.

18 104. 18,111. It also appeared from the evidence of Dr. Thresh, that, at any rate, cockles, and possibly also oysters, obtained from sources far removed from any ascertainable source of pollution, might contain B. coli.

70. We therefore thought it desirable to examine the premise on which Dr. Klein's method is based, namely, the absence of B. coli communis or other B. coli closely allied to it from the normal oyster, and accordingly we instructed our bacteriologist, Dr. Houston, to examine a large number, on the one hand, of oysters from some of the purest waters in which oysters are grown or fattened in this country, and on the other hand of oysters from layings, &c., obviously liable to pollution.

71. A full account of this work is given in Dr. Houston's report. (*See* Appendix, Vol. III.) His investigation has been carried out in the most careful manner, and over one thousand oysters have been examined. The results show that nearly all the oysters so examined, from whatever laying they were taken, contained bacillus coli communis or other B. coli closely allied to it.

72. As regards deep sea oysters the results are not quite decisive, but point strongly to the conclusion that not only typical B. coli but even coli-like microbes are absent from them. Having regard to the results of our examination of other oysters we doubt if, in judging whether shell-fish are fit for human consumption or not, much weight can be attached to a mere statement that in a certain proportion of oysters of a batch the presence of "bacillus coli communis or other B. coli close allied to it," was noted.

73. Notwithstanding the grave doubts raised by the above observations which may attach to the value of the B. coli test, as it has sometimes been practised, we are not without expectation that further inquiry may shew that a quantitative test by aid of these or other micro-organisms may prove of considerable value.

74. The examination of oysters by Dr. Houston, referred to in paragraph 71, was such a quantitative examination. He found that in oysters taken from various layings, the number of B. coli or coli-like microbes varied in an oyster from 10 to 10,000. The volume of a native oyster ranges from 10 to 15 cubic centimetres. *Shell-fish.*

We may here remark that, according to Dr. Houston, the number of B. coli or coli-like microbes per unit of volume in the contents of the stomach of an oyster in the cases examined for this purpose was greater than in the liquor contained within the shell. This result is in contradiction to the opinion which has been expressed that "it makes no difference whatever whether you cut up the whole body of the oyster or whether you take only the fluid which oozes out into the pallial or the branchial chambers." Klein 17669.

75. The result of Dr. Houston's examination, to which we wish to call special attention, is that, as a rule, taking in each case the whole oyster, a very much smaller number of B. coli or coli-like microbes is found in oysters stored in pure waters than in oysters stored in polluted waters.

Our experiments, however, have not been on a sufficiently extensive scale, or sufficiently often repeated, to enable us to say what number of B. coli or coli-like microbes per c. c. might be accepted as a normal average for oysters grown in good waters, and whether it would be possible to lay down a standard which would justify condemnation.

76. If it should be seriously contended that the *mere presence* of B. coli or coli-like microbes in an oyster should condemn it, few oysters would probably escape condemnation. This is a point to which we shall return, but we may at once state that we see no justification for such wholesale condemnation.

77. Another important point to be noticed in Dr. Houston's results, is that while most of the oysters from layings which, to all appearances, are remote from contaminating sources, contain comparatively few B. coli or coli-like microbes, certain of them may sometimes contain as many of these micro-organisms as some of the oysters from obviously polluted waters. It is clear therefore, that a single examination of chance samples of oysters might be most misleading as to the bacterial flora of the whole oyster-contents of a laying or pond.

EXAMINATION OF COMPARATIVE SAMPLES OF WATERS.

78. In carrying out this work in regard to oysters, Dr. Houston was also instructed to make comparative examination of samples of water from the neighbourhood of the different layings.

About eighty water samples were thus analysed; and it was found that, judged by the numbers of B. coli or coli-like microbes per c.c., where the oysters were relatively pure, the water was relatively pure also, and *vice versa.* Generally speaking, however, the water about the oysters was distinctly purer than the oysters themselves. Oysters indeed would seem as it were to collect and retain within their shells these micro-organisms.

79. We have pointed out above that bacteriological examination of chance samples of oysters is apt to be greatly misleading. A similar caution is necessary in the case of waters. We have already referred to the diversity of results of the examination of oysters from a particular source; a like diversity was found on the examination of separate samples of water from one and the same source. Possibly, however, some of the discrepancies in the case of the waters may have been due to differences in the tides.

EXAMINATION OF SEA WATER.

80. Having ascertained that the B. coli or coli-like microbes closely allied to it were generally present in 10.c.c. and sometimes in 1 c.c. of some of the best estuary waters in which oysters are grown or fattened, and that B. enteritidis sporogenes was by no means uniformly absent, it appeared to us necessary to undertake observations with a view of determining whether such micro-organisms form an essential part of the bacterial flora of pure sea water.

Shell-fish. 81. The results are set forth in Dr. Houston's report on the Bacteriological examination of off-shore sea water. (Appendix, Vol. III.)

Thirty-four surface samples of deep sea water were collected on the North-west coast of Scotland within sight of land though remote from all possibility of contamination at separate spots along a line more than 100 miles in length. None of these samples contained any spores of B. enteritidis sporogenes in 10 c.c. and no coli-like microbes of any sort even when using for cultural purposes 100 c.c. of water. It may, therefore, we think, be accepted that these microbes form no essential part of the bacterial flora at the surface of deep sea waters at a distance from land.

82. This is in conformity with results of experiments recorded in the same report, showing how rapidly B. coli disappears in *pure* water, whether salt or fresh.

EXAMINATION OF CHANCE SAMPLES.

83. During the visits of the Commission to various centres of the shell-fish industry round the coast, chance samples of water were collected now and again from estuaries, oyster pits, etc. The results of the bacteriological examination of these and of other samples, which have bearing on the general question, are given in the Appendix, Vol. III.

The total number of samples thus examined was seventy-one.

We have already urged that little weight can be attached to chance examinations. It is, however, of interest to notice that some such samples yielded higher, others lower, results as regards B. coli than we had anticipated from our local observations of the topographical circumstances of the laying.

EXAMINATION OF RIVER THAMES.

84. We have also undertaken an examination of the River Thames and Thames estuary. In connection with this investigation the question of the disposal of the London sludge and other refuse in the open sea has been considered, and for purposes of comparison, some analyses have been made of the River Thames at Sunbury and Hampton above the intake of some of the London waterworks companies. These matters are dealt with by Dr. Houston in his report on the River Thames and Thames estuary, which is published in the separate Appendix to this Report. One of the reasons for making this investigation was the allegation that the discharge of the imperfectly-treated sewage of London into the river at Barking and Crossness and the deposit of sludge and refuse in the open sea at Barrow Deep were causing grave evils. Appendix, Vol. III.

85. As a result of these investigations, we find that, as judged by the B. coli test, the River Thames at Mucking, about 20 miles below the Barking and Crossness Outfall Works, is at times as pure as the River Thames in the region of Sunbury and Hampton, above the intakes of some of the London waterworks companies.

86. As regards change in the biological composition of the water in the River Thames from Barking and Crossness downwards towards the open waters of the estuary, all that need be said is, that whereas at Barking and Crossness the number of B. coli per c.c. of water varied usually from 100 to 1,000, no appreciable improvement was noticeable at Purfleet (about 5 miles below Crossness), but slight improvement at Grays (about 10 miles below Crossness), and that it is not until Mucking (20 miles below Crossness), is reached that the quality of the water is so far improved as to vie with the water in the Upper Thames at Sunbury and Hampton. At Mucking the number of B. coli per c.c. varies usually from 1 to 10, and about 5 miles lower down (at the Chapman Light), it is so far improved that about one-half of the samples contained only one-tenth of this amount.

These results do not support the allegation that the Kent and Essex foreshores beyond the Chapman Light are greatly contaminated by the discharge of imperfectly-purified sewage into the Thames at Barking and Crossness. *Shell-fish.*

87. It will be seen that notwithstanding the daily discharge in dry weather into the Thames at Barking and Crossness, of 230,000,000 gallons of treated sewage, each cubic centimetre of which contains about 100,000 B. coli, and the daily discharge of 7,000 tons of sludge into the Barrow Deep, each gramme of which may contain over a million B. coli, one-half of the samples of water at Chapman Light (about 25 miles below Crossness), and in Barrow Deep were not found to contain 1 B. coli per cubic centimetre. Fitzmaurice, 18494.

The total number of samples examined in connection with these investigations has been 265.

Shell-fish.

CONCLUDING REMARKS ON THE APPLICATION OF BACTERIOLOGY.

88. We find it very difficult to state to what extent bacteriology is to be relied on for the purpose of distinguishing those foreshores, pits, ponds, beds, or layings from which shell-fish are procured, which may be considered safe from those which should be regarded as unsafe, from the point of view of public health.

89. In cases of gross pollution it is obvious that no bacteriological examination is necessary, but where the pollution is slight in amount—so slight indeed that the trained observer would not upon careful local examination of the physical circumstances see any risk of contamination—or where the physical circumstances are such that he would be in doubt, it would seem that we may usefully seek the aid of the bacteriologist.

But it is not clear how far the bacteriologist can at present enable us to measure the risk of contamination.

90. Dr. Klein has repudiated the notion that shell-fish could be condemned solely on account of detection in them of the presence of B. coli. 17740. He said "I myself would not countenance this without the knowledge of 17742. the topographical conditions"; and, again, "I would not myself reject 17788. oysters as polluted with human sewage on account of the purely bacteriological examination."

We are aware that this view of the present limits of bacteriology as applied to shell-fish has not uniformly been acted on, but we see no reason to doubt that it is in the main correct, and that it should be accepted for the purpose of present administrative action.

91. In his report on the results of the examination of samples collected during visits of the Commission to various centres of the oyster industry, Dr. Houston makes the following observation:—

Appendix Vol. III.

> "A pollution trivial in amount but specific in character is much more dangerous than a "contamination gross in amount but non-specific in nature. It is also probable that a pollution "trivial in amount but specific in character and of *recent* sort is more dangerous than a pollution "gross in amount, specific in character, but of remote kind.
>
> "The bacteriologist can do no more than measure the degree of sewage pollution and hence "inferentially the probable degree of potential danger to health. His B. coli results have a "presumptive but certainly not a constant value in relation to disease.
>
> "All waters yielding 10 B. coli per c.c. may be placed in the same class *qua* bacteriological "facts but it is not to be thought of that they all need be of the same class *qua* morbific effect."

Klein, 17743. The methods at present available to the bacteriologist do not permit of his detecting, except possibly in very rare cases, the typhoid fever micro-organism either in sewage largely diluted with sea water or in shell-fish; neither do they enable him to measure, in any exact manner, whether the micro-organisms which he takes as his index of danger are of recent or Klein, 17763-17778. remote intestinal origin. Moreover, there is no constant ratio between the numbers of the organism taken as an index and the numbers of the disease-producing organism in the typhoid fever intestine, in the raw sewage, or in the mixture of sewage and estuary water.

Mere numbers of B. coli or any other particular micro-organism of sewage cannot therefore be said to have anything approaching an exact value as an indicator of the danger of disease, and we consider that before any working bacteriological standard can be applied to this problem further knowledge is necessary.

CONCLUSIONS OF COMMISSION AS TO APPLICATION OF BACTERIOLOGY.

Shell-fish.

92. We accept the view that, for the present, results of bacteriological examinations must be interpreted in the light of topographical observations. As a corollary it would seem that the bacteriologist can at present do little more than urge that results he is obtaining point to the need of a further and more careful examination of the local conditions of the source of the shell-fish or water samples submitted to him; that for the present topographical observations must determine whether any laying or pond is or is not to be considered as free from risk of objectionable contamination.

A striking example of the result of a second visit which was made in consequence of a bacteriological examination, was referred to in Professor McWeeney's evidence (19,539 *et seq.*). Here the local observer passed a situation as relatively free from pollution. The results of analysis suggested that there was a doubt whether this was true, and on further examination a source of pollution was discovered which had at first been overlooked.

93. A further corollary from this view is that by the aid of a bacteriological examination as regards B. coli alone, it would be useless to attempt to condemn shell-fish exposed for sale in a market. This finally disposes of the suggestion that the sale of contaminated shell-fish could, with our present knowledge, be prevented by action under Section 116 *et seq.* of the Public Health Act, 1875.

FURTHER RESEARCH NECESSARY.

94. Although we consider that the bacteriological examination either o sea water or shell-fish, even if carried out in a quantitative as well as a qualitative manner, cannot at present be recommended as a matter of routine for the purpose of distinguishing unsafe foreshores, layings, ponds, &c., the results so far obtained show great promise that by further inquiries, a way will be discovered by which the elements of danger may be defined with much greater accuracy than is at present possible, and it is in our opinion most important that researches in this direction should be continued.

FISHMONGERS COMPANY.

95. Much bacteriological work has been carried out at the instigation of the Fishmongers Company, and we wish to place on record our appreciation of their earnest endeavours to prevent the sale of contaminated shell-fish in London. Having regard, however, to the evidence which we have received, and to the results of our own work, we think that their efforts would have been of greater service had more weight been attached to the topographical examination of the foreshores, layings, ponds, and other places from which shell-fish are procured, and less weight to the bacteriological examination by present methods, of shell-fish themselves.

Wrench-Towse, 19654.

Shell-fish.

FOREIGN SHELL-FISH.

96. The subject of foreign shell-fish does not come directly within the scope of our enquiry, but since in connection with our investigation of the home industry a considerable amount of evidence was submitted to us in regard to foreign layings, it appears desirable that we should make some observations on the question whether, in the interests of public health, restrictions are required in regard to foreign shell-fish.

97. From what has already been said, it will be obvious that it is not at present feasible by the aid of bacteriology to ascertain to what extent, if any, the foreign shell-fish arriving in this country, are specifically contaminated.

As in the case of the home industry, we must have recourse to other methods.

98. It does not appear from our evidence that any outbreaks of enteric fever or other illness, in this country, have been clearly traced to the consumption of directly-imported foreign shell-fish. But there are records of outbreaks of disease in foreign countries due to the consumption of shell-fish from sources exposed to risk of contamination by sewage. Moreover, it is clear from the evidence which we have received, that some of the foreign sources from which oysters and other shell-fish are imported into this country are or were known to be exposed to such risk of contamination. In particular, we may refer to the evidence of Professor Herdman (18,206-18,209), who, several years ago, examined most of the oyster layings in France and Holland, and found that some of the Dutch layings were not only liable to pollution, but were obviously polluted at that time. Again, Captain Anderson stated (16,043), that he knew of foreign oysters that had come from polluted sources, and had been sold direct to the public, and that polluted sources abroad are well known to the trade.

Anderson, 16043-7; 16065.
Baxter, 17,041-5.
Herdman, 18206-7

16047.

99. On the 6th February, 1903, we addressed a letter to the Secretary of State for Foreign Affairs, requesting him to be so good as to make some inquiries for us in regard to the sources of shell-fish in the United States, France, Portugal and Holland. The correspondence is printed in the Appendix, Vol. III.

So far as can be judged by the communications which we have received, it would seem that care is taken in the United States and in France to secure layings against contamination. In France it appears that "as a result of a general inquiry the Fishery Administration ordered the suppression or the removal of certain shell-fish breeding establishments which were pointed out to them as being suspicious."

In Portugal, oyster culture is subject to regulation, but we infer from the Memorandum which has been furnished by the Ministry of Marine that no special provision has been made to secure layings from contamination, and that researches have shown that in certain conditions the layings may become contaminated by "abundant pathogenic bacilli."

We have received no communication in regard to Holland.

RECOMMENDATIONS AS TO FOREIGN SHELL-FISH.

100. As a result of the consideration of the whole of our information we think that, in the interests of public health, some safeguards are necessary in connection with the importation and sale of foreign shell-fish.

It has been suggested that all consignments of foreign shell-fish should be required to be relaid for some period in approved waters before being sold to the public. We doubt, however, whether such a requirement could be justified in the case of all foreign shell-fish. And, moreover, the purifying value of relaying shell-fish, at any rate for a short period, is at present

Niven, 17845.

uncertain. We shall deal more fully with the general question of relaying shell-fish in the next section of this report. *Shell-fish.*

101. For the present, we think that it would be a sufficient precaution to require a guarantee on the part of each Government concerned, that *all oysters or other shell-fish imported into this country for human consumption had been procured from localities where they were not liable to be contaminated by sewage or other objectionable filth.*

We may here mention that both the American and Dutch authorities do, at the present time, issue a form of certificate, relative to oysters which are despatched from their countries.

In addition to asking for such a guarantee we think that the Government of each country should be requested to grant facilities to an accredited representative from the Central Authority in this country to inspect from time to time the layings, ponds and other places from which shell-fish are imported.

Failing such guarantee and permission, all foreign oysters or other shell-fish imported for human consumption, should be deposited in registered layings or non-prohibited areas in this country for a period of not less than six weeks antecedent to their disposal on the market.

Shell-fish

RELAYING OF SHELL-FISH FOR THE PURPOSE OF PURIFICATION.

102. The subject of relaying shell-fish is one of great practical importance, for if it be true, as has been stated, that shell-fish from doubtful sources when relaid for a short period in approved waters rid themselves of micro-organisms which might give rise to disease, the problem of dealing with contaminated shell-fish would be, in many cases, much simplified.

103. In regard to this question Professor Herdman referred us to some experiments which he and Professor Boyce carried out a few years ago, and our attention was also drawn to some similar investigations made by Dr. Klein and others.

Klein, 17,805–17,807.

So far as can be judged from these experiments it would seem that polluted oysters placed in approved waters might free themselves from dangerous organisms in the course of a comparatively short period; but Dr. Klein finds reason to think that, as regards cockles and mussels, relaying might be in this sense less effective; he suggests indeed that B. coli might multiply in these shell-fish and possibly therefore B. typhosus also.

With regard to cockles and mussels it is possible that these molluscs can be so thoroughly boiled as to bring about the destruction of pathogenic organisms without at the same time rendering the mollusc itself uneatable, and if this proves practicable in general application, these molluscs would take their places amongst the fish which are thoroughly boiled before consumption. But it would, in our scheme, devolve upon the Rivers Board to draw up by-laws or regulations relative to the treatment to which all shell-fish should be subjected, and this matter may, therefore, be left in their hands.

104. We doubt whether the experiments above referred to have been on a sufficiently extensive scale to justify the making of any precise statement as to the effect of relaying. The failure with the methods at present available to the bacteriologist to identify B. typhosus in an oyster in which B. coli or coli-like microbes are present, is no proof that the oyster does not contain this micro-organism, and we considered, therefore, that it was not practicable to make a direct experiment with the typhoid bacillus; the problem must be attacked in an indirect way.

It seemed to us probable that, although a certain number of B. coli and coli-like microbes are, so far as our investigations show, normally present in oysters even from good layings, if oysters containing an excessive number of these micro-organisms were used for the experiment, and relaying considerably reduced the number, we might infer that relaying was of real value for the purpose of removing the typhoid fever or other disease-bearing micro-organism.

Appendix Vol. III.

105. In the limited time at our disposal we have only been able to carry out one experiment on the point. Full details of the experiment are contained in Dr. Houston's report which is printed in the Appendix. The results of the experiment point to the need of further investigation.

We fully realise that such an indirect experiment is by no means conclusive, and it is, we think, probable that the typhoid fever micro-organism would die out sooner than the B. coli and coli-like microbes. We should hope that with the advance of the science of bacteriology, it may be possible to devise some method by which the presence or absence of B. typhosus and other micro-organisms capable of giving rise to disease, may be established with facility and certainty.

106. The relaying of shell-fish is a subject of considerable importance, not only from the point of view of public health, but also from that of the trade, and we therefore strongly recommend that the new Central Authority should undertake, as one of its earliest pieces of work, the systematic investigation of this question.

OTHER DANGERS WHICH MAY ARISE FROM THE DISCHARGE OF CRUDE SEWAGE OR OF TRADE EFFLUENTS INTO TIDAL WATERS.

Injury to Health and to Fish.

107. In an earlier part of this Report, we have pointed out that, in addition to the contamination of shell-fish, other evils may arise from the discharge of crude sewage or trade effluents into tidal waters. These evils may be classified under two heads, viz.: injury to health and injury to fish.

INJURY TO HEALTH.

108. It will be seen from the evidence of Dr. Thresh, the Medical Officer of Health to the County Council of Essex, that the districts in Essex bordering on the Thames, and from which crude sewage is discharged on to the foreshore, have had a "very much higher mortality from typhoid fever than the other parts of the county," and that "that is not an accidental occurrence, one year now and again, it is every year, every year without exception." Thresh, 8847.

109. We have also received evidence to shew that, apart from cases of specific disease, like typhoid fever, offensive emanations from sewage-polluted tidal rivers may cause general deterioration of the health of the people living near the river; and more particularly give rise to the prevalence of sore throats. Moreover, it would seem that at times the deposit of fœcal matter on foreshores may give rise to serious nuisances. Thresh, 8839-46. Hill, 9030-40.

POLLUTION OF BATHING GROUNDS.

110. As regards the pollution of bathing grounds we have received little evidence. It is obviously undesirable that sewage should be present in such places; and in this connection, we may observe that Dr. Klein, when he gave evidence before us in 1901, referred to the possibility of dangerous conditions arising from polluted waters, containing the pathogenic organisms common to sewage, being brought into contact with the human body, or actually swallowed through bathing. But it does not appear that any serious injury to public health is to be feared from pollution of bathing grounds by sewage, if reasonable care is taken in selecting positions for outfalls. Klein, 9678-9. Klein, 9697-9.

111. The evidence which we have received rarely shews that the dangers to health arising from the discharge of untreated sewage or trade effluents into tidal waters, apart from the contamination of shell-fish, are of great magnitude. In some cases we think that disease may have been attributed to this cause on insufficient ground. Yet, in the interests of public health, some restrictions may in certain cases be desirable.

INJURY TO FISH.

112. The evidence we have received shows that the discharge of crude sewage or trade effluents into tidal waters may injuriously affect fish in the following ways:—

i. By reducing the oxygen in the water to such an extent as to render the water incapable of supporting fish life.
Herdman, 8709-15; 8758-9. Pelham, 8769. Hill, 9055-6. Clowes, 18721.

ii. By the admission of poisonous matters into the water.
Herdman, 8672, 8720-4. Pelham, 8769. Williams, 9819, 9869.

iii. By destroying the food of fish by deposits of sewage matter.
Herdman, 8672; 8690-2.

iv. By the presence of suspended solids which clog the gills of the fish.
Herdman, 8672; 8680-4; 8726-32.

113. As a result of the consideration of this evidence we consider that in the interests of fisheries also, some restrictions may in certain cases be desirable.

Injury to Health and to Fish.

In this connexion, we may refer to the following extracts from the Report of the Royal Commission on Salmon Fisheries, as regards injury caused to salmon fishings by the pollution of rivers :—

"Before dealing with the influence which, according to the evidence put before us, pollutions "have exercised on the Salmon Fisheries of England, Wales, and Scotland, it is desirable to "consider what is known of the effect upon fish life of the constituents of sewers, manufacturing "effluents, and other sources of pollution which enter rivers and estuaries, and to discuss the "manner in which the effect of such pollution is modified by the character of the river and the "place of discharge of the polluting matter. A number of experiments upon the subject have "been conducted, chiefly in Germany, but although they have considerably advanced our know"ledge, they are not sufficiently numerous, and require to be repeated and extended.

"Ordinary domestic sewage does not contain any directly toxic substance, but when its "organic matter undergoes bacterial decomposition, it becomes injurious in two ways:—

"(i.) By actively taking up oxygen in the process of decomposition, and thus deoxygenating "the water of the river.

"(ii.) By yielding toxic substances as a result of decomposition.

"Under ordinary conditions river water contains something like 6 c.c. per litre of dissolved "oxygen; but as a result of the decomposition of organic matter, this may be used up faster "than the water can take it from the air, and thus the dissolved oxygen may partially or entirely "disappear from the water. Information is required as to the extent to which water may be "deprived of oxygen without endangering the life of fish. The experiments which have been "already conducted have been of too short a duration, and are insufficient in number. But the "series of observations made by Dr. Noel Paton, so far as they go, confirm the conclusion "enunciated by Messrs. Dibdin and Thudichum that water with less than 3 cc. of oxygen per "litre must be considered injurious to salmonoids.

"Of the substances developed in the putrefaction of sewage hydrogen sulphide appears to "be the most injurious to fish. Substances poisonous to fish may also be added to sewage "as disinfectants or deodorisers. Among these are chloride of lime and carbolic acid.

"When the effluents from manufactories contain large amounts of organic matters, as is the "case in the untreated effluents from breweries, distilleries, paper works and tanneries, &c., they "act like sewage in depriving the water of oxygen. But many manufactories discharge sub"stances which are directly toxic. Among these are the chlorine from bleaching works, paper "works, &c., the acids from steel works and tin plating works, the alkalis from wool washings, "the gas lime, cyanides, and carbolic acid from gasworks, and the organic acid in the pot ale of "distilleries. A number of witnesses have spoken to the consequent danger of occasional "or accidental poisoning of salmon, and among instances which might be quoted is a case in the "Forth, when 400 dead fish were taken out, and it is stated that in the Doon on five several "occasions during the last thirty years fish were poisoned.

"The fine detritus of coal washings may act as an irritant to the gills of the fish, and by "forming a deposit on the river bed prevents the free passage of oxygen to the ova. From "certain old mines containing iron pyrites an acid water is discharged, which is very toxic "to fish.

"The character of the river into which the effluent falls has a marked influence upon its pre"judicial effect. If the stream is rapid, large quantities of organic matter may undergo "decomposition without materially diminishing the dissolved oxygen, since the swift flow "causes a constant renewal of the supply from the air. Similarly a rapid stream quickly carries "along and dilutes toxic agents. It is when the effluent is poured into a sluggish part of the "river, or when the polluted water is dammed back by the tide in the estuary that the effects "of pollution become really marked. If, in addition to the stream being sluggish at the point "of discharge, there is any obstruction to the passage of fish up and down, the injurious action "of the effluent is increased. Thus effluents discharging under weirs are specially injurious to "ascending fish, while when they discharge above a weir they must be equally injurious to "descending smolts and kelts. Pollution of the estuary due to the damming back of the water "loaded with organic matter, and possibly with toxic substances, is perhaps of greatest "importance, since it offers a serious obstacle to the passage of salmon into the river, and "constitutes a danger to descending smolts and kelts which have to pass through it to reach the "sea. This condition has been fully investigated in the Thames, and during the summer of "1901 in the Tyne, in the Ribble, and in the Ouse."

REMEDIES.

Cd. 1198 (1902), p. 46.

114. In the Report to which we have referred, the Royal Commission on Salmon Fisheries expressed the hope that steps might be taken to secure that our inquiry would not be closed without an authoritative declaration of the standard of the effluent that can be permitted in estuarial as well as non-tidal waters, having regard to the reasonable protection and encouragement of the salmon fisheries of the country. We do not, however, think it practicable to lay down standards applicable to all rivers and estuaries. The necessities of each case would depend on a variety of considerations, such as the volume of tidal water compared to the volume, character, and strength of the polluting liquid, the rate of flow of the river and its shape, &c.; moreover,

in dealing with any case due regard must be had to financial considerations. It appears to us, therefore, that the right course to adopt is to provide adequate machinery, by which such restrictions can be imposed as and when required.

Injury to Health and to Fish.

This machinery should, we think, be that which we have recommended in the first branch of this report, dealing with the contamination of shell-fish, that is to say, Rivers Boards and a Central Authority. In our opinion these bodies should have general control over waters so far as the prevention of pollution is concerned.

We have pointed out that for the purpose of control in regard to shell-fish, Rivers Boards such as we have in view should make a careful survey of all tidal waters within their jurisdiction, and obtain full information as to the conditions of such waters in relation to pollution. The further matters dealt with in this branch of our Report, would, therefore, suitably fall within their jurisdiction.

PROCEDURE.

115. In considering the question of restrictions, due regard must be had in each case to the extent of the evil, to the possibility of providing a remedy, and to the cost. It is quite possible that in some cases where there was no risk to public health, the cost of providing a remedy might be altogether out of proportion to the value of the fishing interests involved.

Where, however, after due investigation, the Rivers Boards consider that serious nuisance to the inhabitants on the banks of the tidal river, estuary, or sea-front of a town, or serious injuries to public health or to fisheries are caused by the discharge of crude sewage or trade refuse into tidal waters, and they are satisfied that by the alteration of the position of the outfall, or by the adoption of such treatment of the sewage or trade effluent as is available and practicable under the circumstances, an efficient remedy would be provided, and might reasonably be required, those Boards should be empowered to make orders accordingly. Such orders should be subject to confirmation by the Central Authority, and the procedure to be followed should be that indicated in the first branch of this Report under the heading "Procedure" (paragraph 57).

STANDARDS FOR TIDAL WATERS.

116. In connection with the question of standards as regards offensive putrefaction and injury to fish, we may state that much work has already been done, both in this country and abroad. We have therefore thought it desirable that the results of this work should be collected and collated. Mr. E. A. Letts, D.Sc., F.I.C., Ph.D., Professor of Chemistry at Queen's College, Belfast, and Mr. W. E. Adeney, D.Sc., Vice-President of the Institute of Chemistry, Curator and Examiner in Chemistry in the Royal University, Dublin, have kindly arranged to do this and to report to us on the question how far these results may suffice to show the conditions under which tidal rivers would become (a) a nuisance in consequence of offensive putrefaction or (b) injurious to fish, either in consequence of the diminution of oxygen or the presence of poisons. The results so collected will, we hope, be of considerable use in enabling each Rivers Board to deal with waters under its jurisdiction.

PAPERS PRESENTED WITH THIS REPORT.

117. The following supplementary volumes are presented with this Report :—

Vol. II. The Minutes of Evidence.

Vol. III. Reports made to us by Dr. Houston on the results of the bacteriological examination of certain samples of water and shell-fish which he has carried out under our direction.

Correspondence with certain Foreign Countries as to imported shell-fish

Vol. IV. Reports made to us by Dr. McGowan, Dr. Houston, and Mr. Kershaw on certain investigations which we directed them to make in regard to land-treatment of sewage. Report by Dr. McGowan on methods of chemical analysis as applied to sewage effluents.

We have considered it desirable to publish, at this stage, the results and information which have been obtained by our own officers in regard to land-treatment of sewage and methods of analysis, but we shall defer reporting on these matters until our investigations, which are now in progress, in regard to other methods of sewage-treatment, are completed.

(Signed) IDDESLEIGH, Chairman.
C. PHIPPS CAREY.
M. FOSTER.
T. WALTER HARDING.
WILLIAM RAMSAY.
JAS. B. RUSSELL.
W. H. POWER.
T. J. STAFFORD.

F. J. Willis, Secretary.
28th December, 1903.

ROYAL COMMISSION ON SEWAGE DISPOSAL.

FOURTH REPORT

OF

THE COMMISSIONERS

APPOINTED IN 1898

TO INQUIRE AND REPORT WHAT METHODS OF

TREATING AND DISPOSING OF SEWAGE

(INCLUDING ANY LIQUID FROM ANY FACTORY OR MANUFACTURING PROCESS)

MAY PROPERLY BE ADOPTED.

POLLUTION OF TIDAL WATERS,

WITH SPECIAL REFERENCE TO

CONTAMINATION OF SHELL-FISH.

VOLUME II.

MINUTES OF EVIDENCE.

Presented to both Houses of Parliament by Command of His Majesty.

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MINUTES OF EVIDENCE

TAKEN BEFORE THE

ROYAL COMMISSION

APPOINTED TO

Inquire and Report: First, what method or methods of treating and disposing of Sewage (including any Liquid from any Factory, or Manufacturing Process) may properly be adopted consistently with due regard for the requirements of the existing Law, for the protection of Public Health, and for the economical and efficient discharge of the duties of Local Authorities; and if more than one method may be so adopted, by what rules, in relation to the nature or volume of Sewage, or the Population to be served, or other varying circumstances or requirements, should the particular Method of Treatment and Disposal to be adopted, be determined; and, secondly, to make any Recommendations which may be deemed desirable with reference to the Treatment and Disposal of Sewage.

FIFTY-SIXTH DAY.

Tuesday, 24th February 1903.

PRESENT:

The Right Honourable the Earl of Iddesleigh (*Chairman*).

Sir Michael Foster, K.C.B., F.R.S., M.P.	Mr. W. H. Power, C.B., F.R.S.
Sir William Ramsay, K.C.B., F.R.S.	Colonel T. W. Harding, J.P.
Major-General C. Phipps Carey, C.B., R.E.	Dr. James Burn Russell.

Mr. F. J. Willis, *Secretary*.

ALSO PRESENT—

Dr. A. C. Houston. | Dr. Bulstrode.

Mr. R. A. Dawson.

24 Feb. 1903.

Mr. Robert Arthur Dawson, called; and Examined.

16298. (*Chairman.*) You come here representing the Lancashire and Western Sea Fisheries district?—I do.

16299. And would you mind stating the limits of your jurisdiction?—The jurisdiction extends from the north side of the River Duddon in Cumberland down to Kemmaes Head in Pembrokeshire. It takes Lancashire, Cheshire, Flintshire, Denbighshire, Carnarvonshire, Anglesey, Merionethshire, and Cardiganshire.

16300. Then, it takes the greater part of the Welsh coast?—It does, yes.

16301. And the whole of Lancashire?—And the whole of Lancashire and Cheshire.

16302. And how far up the several estuaries does your jurisdiction extend?—It varies in different rivers. In the northern rivers we generally take the first viaducts. For instance, in the Mersey it goes up to Runcorn Bridge. In the Ribble to Penwortham Bridge, and in the Lune to the railway bridge there. In some of the Welsh rivers it does not go quite so high up.

16303. And what kind of staff do you have?—We have a number of fishery officers. We have fourteen fishery officers and a number of assistant officers that are paid a small retaining salary a year. They are not regularly on the work. They report any cases against the bye-laws that come under their notice, but they do other work. Then we have a steamer, with eleven of a crew. All the crew are fishery officers. Then the other fishery officers about whom I spoke first, they have sailing cutters; we have four large sailing police cutters. The district is divided into divisions, and we have a head fishery officer and two under ones on the different portions of the coast, and they have charge of that particular portion. They supervise not only the sea fisheries, the fish nets, but also the shell fish beds.

16304. And, now, do you have complete facilities for visiting the different fisheries?—Yes, we have.

16305. There are no difficulties in that respect?—None whatever.

16306. Well, then, have you any facilities for either bacteriological or chemical examination of the shell fish?—Yes, we have, at a place called Piel, near Barrow; we have a laboratory there, and a resident scientist, and also we have a laboratory at Liverpool, with another assistant scientist there, and Dr. Herdman is the honorary director of the whole of the scientific work, and he examines shell fish and also other fish for us.

16307. And does he also examine the sewage that approaches the beds where the shell fish are?—No, he has not done it for the Committee, but with regard to oysters he has, I believe.

16308. Do you have any medical officer of health to advise you?—Yes, the medical officer of health of the county of Lancashire sometimes assists us. When there are complaints about sewage being detrimental to shell fish, he will visit the place, and report on the matter.

16309. That is a part of his duty, is it?—Yes, that is a part of his duty.

16310. That you can call him in if you wish to do so?—Quite so; in fact, the Committee are now arranging a thorough inspection of all the shell fish beds in the district, and he has been asked if he will take part in it as far as regards Lancashire, and he has promised to come round and give all the assistance he can.

16311. Then you are satisfied, are you, with the assistance you get, both in examinations and in medical advice?—Yes; of course, it is a question that has not been gone into very deeply yet. My Committee are only beginning to wake up to the fact that something will have to be done with regard to this matter, and I think the Lancashire and Western Sea Fishery Committee have at their disposal most of the help they require through the medical officer, the scientists, and the staff.

16312. Well, now, would you give us quite a brief outline of the following industries in your district, and indicate on the map the position of the several beds, "layings," etc.: The cockle industry, the mussel industry, the periwinkle industry, and the oyster industry?—I have marked the beds roughly on charts, but the time at my disposal since I was called upon

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to give evidence has been too short to get them properly ready; the cockle beds are coloured green, the mussel beds blue, and the periwinkles yellow, and oyster layings are brown. And I have marked several sewage outfalls; for instance, here at Morecambe are the shell fish beds, and here are the different sewer outfalls. (*Witness indicated on the plan the position of the several beds, "layings," etc.*) (*See* Charts I. to VI. following page 8.)

16313. Now, may I ask you whether you have any reason to know, or to suppose, that there are, or have been, any infected shell fish in your district?—Any infected?

16314. Infected?—Yes, the bed at Egremont; I think there is little doubt that that has been infected. The report of the medical officer of health at Wallasey about the sewer pipes, and about people gathering the mussels points to this; he wrote me, and said it had come under his notice that a father and son eating mussels from the very same place both developed typhoid fever, and one of them died.

16315. And has your Committee taken any action to protect the shell fish from pollution?—They have taken no action, except to report to the medical officer of health at one or two places, and drawing attention to certain beds where in the opinion of the Committee mussels are polluted.

16316. Has your Committee got any powers to do anything?—They have power to make bye-laws to prevent any discharge which is detrimental to sea fish or sea fishing if the power to discharge is not taken under the Act. If the authorities have an Act the Sea Fisheries Committee cannot do anything.

16317. But can you interfere with the discharge of a sewer where that sewer has been discharging for years?—No; I do not think we have any power for that.

16318. And have the efforts which have been made, I believe, in your district, to adopt the Bonchot system of mussel culture, been successful?—It was tried; several experiments have been tried, but in those instances it was not a success, and it is not carried on now. It was tried in Morecambe Bay; it was also tried near Hilbre Island, but it did not answer in that district.

16319. Then you cannot say that your experiments have been successful?—They were not satisfactory.

16320. And how many persons are there engaged in the shell fish industry in your district?—I should say there are about 500; I have not got the exact number.

16321. And has it been your practice in the past to attend Local Government Board inquiries as to sewage disposal which have been held in your district and put before the inspector the conditions as to shell fish distribution in the vicinity of the proposed outfall?—No, my Lord.

16322. And have you power to register oyster layings or mussel layings or cockle grounds?—No, we have not.

16323. Have you power to prevent those shell fish from being dredged or gathered from a source, if you considered that source was polluted?—We have not.

16324. And has your Committee taken any action under the Sea Fisheries Regulation Act of 1888, with regard to prohibiting the discharge of solid or liquid substances detrimental to sea fish?—Not to sea fish; they have taken action in cases where the discharge has been detrimental to sea fishing. For instance, the hoppers bringing the dredged material or refuse down the Liverpool Channel and depositing it on the fishing grounds; in one or two cases the captains have been proceeded against.

16325. (*Sir Michael Foster.*) I suppose that in most of the cases the shell-fish beds—cockle, periwinkle, mussel, and oyster—are older than the sewers, or are there cases, or many cases, where the beds have come into existence after the formation of the sewer?—No, I do not think so. I think the beds have been there prior to the sewers. Of course, I cannot speak of some places; I am only speaking of the few that I know about. I should say St. Annes and Morecambe, and a few places like that, the beds were there prior to the sewers coming there.

16326. That was rather singular, that little mussel bed that you pointed out in the Menai Straits, where the mussels—I think it was the mussels—seemed to be gathered round the outfall of the sewer?—Yes. I think that has arisen. The spat of mussel must have something solid to stick to, and about that district it is sand, and that is the only place where the spat will stick.

16327. It is probable in that case that the sewer has been the cause of the formation of the mussel bed?—I think in that case it is.

16328. And therefore it might occur again, I suppose?—It might. Yes.

16329. Then probably the presence of the sewage is favourable to the deposit of the spat and also, possibly, I mean, the mussels feed upon some part of the sewage?—That may be so.

16330. Have you noticed many other cases where mussels have seemed to come round a new sewer?—No, I have not. They do grow on the sewer mouths, but I have not known any particular cases, except the one I mention, where beds have been formed after the sewer has been placed there.

16331. Is there any evidence that the untreated sewage is injurious to the mussels and cockles—the shell-fish themselves?—I do not know that there is, with the exception that in opening the fish they are very sickly-looking and full of slime, but they still live. As far as an expert's opinion—it is more a matter for a scientist—it is impossible to say whether it is injurious to the mussel itself; they certainly appear to thrive in places where the sewage comes.

16332. That, on the whole, the mussels and other shell-fish which are in the beds in the vicinity of sewers are certainly as good and possibly better than those in other localities?—They appear to thrive.

16333. So that the sole difficulty that we have to deal with is the effect of the shell-fish when eaten by man?—Yes, that is, of course, different; that is where the danger comes in.

16334. I see you referred to the untreated sewage?—I did; yes.

16335. What do you exactly mean by the treated; how far treated? I mean in this way: the danger to man in the shell-fish is the presence in the animal of disease germs?—Yes.

16336. And not of other constituents of the sewage?—Yes.

16337. So the treatment of sewage which you would desire most, at all events, includes the removal of the germs?—To be of any use, that would have to be done.

16338. I mean, short of that, is it of any use?—None; no.

16339. I mean mere partial purification of the sewage, which, supposing that it leaves the germs still there, would, from the point of view that we are considering now, be useless?—It would not have the desired effect.

16340. I mean there would be no reason to interfere, would there?—No, not unless you got the poisonous matter away.

16341. I did not quite understand what power you had—the Sea Fisheries Committee—under the regulations of the Fisheries Act of 1888; in your bye-laws, I mean; how far you could go?—The power they have is to regulate the size at which shell-fish may be taken. They can also regulate the season at which they shall be taken and the manner in which they shall be taken.

16342. But you can form bye-laws, can you not, to prevent certain things which are injurious?—The discharge of matter injurious to shell-fish, but I do not think we have power to prevent anything which is injurious, unless it is injurious to the shell-fish. I do not think we have the power to set up a bye-law to prohibit the taking of shell-fish because they are injurious to the person eating them.

16343. Has it been brought into a court of law at all; I mean the carrying out of these bye-laws?—We have had many prosecutions about taking shell-fish of illegal size.

16344. No, but with regard to the refuse and so on detrimental to the fishing?—We have had cases—the ones I mentioned to you about the deposit of dredged material on the fishing grounds.

16345. Of dredged material?—Yes.

16346. But not of sewers?—Not of sewers.

16347. I suppose your Fishery Committees have a great deal to do now, have they not, and probably may have more to do in the future?—That is so; they have a good deal to do.

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16348. If certain things which are in the air are carried out, further duties will be placed upon the Fishery Committees?—Yes.

16349. With regard to the prosperity of the fishing industry in general?—Yes, they have.

16350. So that, I suppose, you would be unwilling to undertake distinctly sanitary duties?—The opinion of the committee—many of them, at any rate—is that, owing to their officers being continually on these beds, they are the people who have the most chances of reporting anything that is wrong.

16351. Reporting, rather than of taking action?—Rather than of taking action, except it is thought they ought to have the power immediately to close a bed, pending further action of the Local Government Board or some other authority.

16352. That is to say, in a case where a sewer is allowed to dribble on to a shell-fish bed, you should always have the opportunity of reporting that?—Yes.

16353. And, further, that if, as the result of that, there is to be an inquiry which is to take some time, you should have the right of closing the bed?—Quite so; that is the view.

16354. Would, in that case, any question of compensation to those who use the bed or own the bed come up; would you take the responsibility of that?—I do not think so; I think it would be more a matter for the Local Government Board as regards the compensation. The committee have no funds at their disposal that they could grant them compensation.

16355. I see. In the case you mentioned just now of the typhoid fever, was that completely worked out; were other causes of the typhoid fever excluded; was it a case which was thoroughly worked out?—I got the case from the medical officer from Wallasey, who writes to me that he saw these men eating these fish. His attention was called to it; and it was followed by typhoid fever, and death in the case of one; both had typhoid fever. I am not sure whether he attended the cases himself or not, but the matter was brought under the notice of the Urban District Council, and they caused notices to be put up along the shore, saying that the shell-fish there was detrimental to health; but beyond that they had no power to go, as a matter of fact.

16356. The question that I asked was whether it was a case in which the cause of the typhoid fever was clearly proved. We might have a suspicion that it was due to the shell-fish without its being scientifically substantiated?—It was clearly proved to the satisfaction of the medical officer there. Of course, I did not know personally the people.

16357. Is it on record anywhere?—I have his letter here, if you would like to see it.

16358. If you could just state what case it was—I mean the medical officer's letter—so that one might refer to it; if you just give it in to the Secretary?—Yes, I will.

Wallasey Urban District Council,
Sanitary Department,
Egremont, Cheshire,
January 23rd, 1903.

Dear Sir,—I beg to asknowledge receipt of your note and enclosure with reference to the taking of mussels for food from the Egremont foreshore. I am so well aware that this practice constitutes a danger to health that years ago I made a full report to my Council on this matter, more especially with regard to the very position you mention—by Egremont Ferry Slip. At that time my attention was drawn to it by two persons, a father and son, eating mussels or cockles quite raw as they gathered them at this spot, the consequence being that they both developed typhoid fever in a very severe form, and one of them died. After repeated representations to the Health Committee, I was able to secure a resolution by which notices were put up all along the river wall, from Seacombe to Shore Road on the Wallasey Sandhills, pointing out that the gathering of mussels along the foreshore was dangerous and forbidden. Further than this, however, our law clerk said we could not go, and that we had no power to prosecute. I shall be glad, therefore, if you can suggest anything further that may lie in the power of our District Council to do with a view to puting a stop to this dangerous practice. It appears to me that, until Government places more power in our hands, we are pretty well helpless in the matter.

I am,
Yours faithfully,
A. Craigmile,
Medical Officer of Health.

R. A. Dawson, Esq.,
Lancashire and Western Sea Fisheries,
Superintendent's Department,
2, Garden Street,
Preston.

16359. I gather from your statement that you have made complaints about sewers and sewer outfalls which have not, in your opinion, been properly attended to?—We have made complaints in the cases I have mentioned before, but nothing appears to have been done with the exception that I think one pipe was lengthened on the Seacombe shore.

16360. Your experience is not limited to that one case, is it?—No.

16361. Is that the only case in which you have reported as to the injurious effects of the sewer, and nothing has been done?—No, it is the only case that we have reported to the authorities. We have had complaints about sewage being detrimental to shell fish in other places, and we are at the present time investigating them, together with the Medical Officer for Lancashire, but no report has been made to any of the authorities as yet.

16362. You think that action ought to have been taken?—It will be taken as far as regards reporting if it is found on further examination that there is a necessity for it.

16363. In the statement which has been circulated to us you speak of the necessity of medical officers of health giving this subject their prompt attention, as if your experience had been that they had not given it their prompt attention?—Well, I do not think that they have given sufficient; they have given a certain amount, but they appear now to be only just waking up to the matter, and in my opinion they certainly should give more time to it.

16364. Can you explain how in such an important matter they have not given the prompt attention that you think they ought to have given to it?—I could not say how it is. I suppose they have been filled with other work, and it is a matter that has, perhaps, not come so much under their notice until the recent oyster scare.

16365. But you think that if they were adequately influenced by public opinion they might be led to remedy the matter, that it would be sufficient if you report to them?—No, they would require power to do this; power to act would have to come from somewhere to do any good.

16366. They have not, in your opinion, at present adequate power?—No.

16367. Then those are the two points, I think, that you want to impress upon us, Mr. Dawson, one that you ought always to report such cases as come to your notice, that it should be part of your duty to report such cases?—Quite so.

16368. And further, that you should have the power to close such beds as were, in your opinion, liable to contamination by sewers?—My opinion is that Sea Fishery Committees on receiving a report from their officers, and again after having the shell fish scientifically examined, and then if found polluted that there and then they should, pending a Local Government Board inquiry, have power to close the bed until that time arrives.

16369. That is a power that you have not now?—That is a power which we have not.

16370. And which you desire to have?—Yes.

16371. (*Sir William Ramsay.*) Am I right in supposing that the matter stands thus: regard is paid to the health of shell fish, or to the health of fish in general, but no attention is paid to the health of the persons who consume those fish?—Not under the present power.

16372. Then you would desire to have the health of the persons who consume the fish brought in as well as the health of the fish, because healthy fish might

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produce disease in persons?—We desire to have the power to protect the public—at any rate, to assist to protect the public from the possibility of taking poisonous shell fish; it would be looked upon, at any rate, as one step in the right direction.

16373. Would it be possible for your inspectors to form an opinion on the matter; would they be guided by the appearance of the shell fish, or by any complaints reaching them, or by the position of the sewers in reference to the beds? How could your inspectors form definite opinions on the matter?—They would form an opinion, first, by the look of the fish; then by the proximity of the sewage outfall, and they would send samples to the different laboratories that we have to have them thoroughly examined.

16374. (*Sir Michael Foster.*) You did not propose to take action, I understand, at all, I mean to report, until you had an adequate scientific proof that the shell fish in question were doing the evil stated?—No. What I mean is this, that the officers first of all report to the committee that in their opinion there is something wrong with these fish. They can tell whether the fish is sickly or whether it is not. You can tell whether they are covered with sewage. As a matter of fact, in some of those places they get quite a brown colour through being covered with it. Then, after reporting this matter they would also send a sample of shell fish to the laboratories to have them examined, and from that report then the committee should have power to stop them from being taken for food pending further action by a different authority.

16375. (*Sir William Ramsay.*) Are there other places along the coast where shell fish might be placed equally well, or might flourish equally well with those you have shown us, which are not exposed to sewage pollution, or do those beds which you have shown us represent the total available ground?—There is very little other available ground. For mussels, of course, you must have secure ground for them to attach themselves, and most of the parts are sand or rock. They will not attach themselves very well to rock; it is a gravel bed they like.

16376. So that the possible positions are limited?—They are limited. Yes.

16377. And if the sewage outfalls cannot be altered, that means that the beds must be shut up for good and all?—Yes; I think, however, there are cases where the danger would be lessened by lengthening the sewer pipes to get the discharge placed where the tide is strong. In some places I pointed out to you on the map this morning, they did not come nearly down to low water.

16378. The sewage outfalls?—The sewage outfalls. If they are carried further out to where the tide is stronger, it would have more chance, at least, in my opinion, of getting away, and getting further to sea, but the sewage should only be discharged at certain times of the tide when the tide is ebbing.

16379. (*Mr. Power.*) Have you made any representations to the local authorities within your area as to risk to oysters as contrasted with cockles and mussels?—No, we have not as regards oysters.

16380. You have not had occasion to do so?—No, we have had no reports that oysters were being damaged by sewage.

16381. Do you yourself make reports quarterly or annually to the authority you represent on your operations during the year?—I do, sir.

16382. Are they published? Are they generally available?—Yes, they are published. I make quarterly reports, and they are all published.

16383. And an annual report as well?—Not an annual report; an annual report is made from the scientific department.

16384. Are these reports of yours distributed to the local authorities that might be concerned in these matters; does your Fishery Board issue them generally, or, if the local authorities have not sufficient interest in the matter, do they not see them?—The reports are printed and sent round to members of the committee, to the different newspapers and to anyone that care to have them, but they are not publicly distributed.

16385. Do they generally appear in the local papers?—They do; that is, not the whole of the reports, but the main points generally appear in the local papers.

16386. Would what you have to say as to the danger incurred by shell fish by particular outfalls, would those parts be published, do you think?—They are; I made a report, and a portion of my last quarterly report mentioned the latter, and I saw it in one or two of the papers.

16387. Then, does your authority ever send these reports of yours which particularise the risk to fish directly to the authority concerned; do you enter into correspondence with the authority on the matter?—They have not; not to my knowledge. A copy of the reports goes to the Board of Trade; they are sent each quarter to the Board of Trade.

16388. They go each quarter as a matter of course to the Board of Trade, I suppose?—Yes.

16389. All your reports?—Yes, to the Fishery Department.

16390. (*Major-General Carey.*) Your suggestion that the attention of medical officers in the county or medical officers to local authorities should be drawn, if possible, to the contamination of shell fish beds, is, of course, confined to the beds within their jurisdiction?—Yes.

16391. Is there any authority who would call attention to beds outside their jurisdiction?—I could not say that. The Medical Officer of Health for the County of Lancashire is going to give us all the assistance he can, but it will have to be confined to Lancashire. He said it would be going outside his duty to go over the whole district.

16392. The bounds of your jurisdiction extend a certain distance only up a tidal estuary?—Quite so.

16393. And immediately above that there may be oyster beds or shell fish beds?—Yes.

16394. Which might escape attention for want of any authority to draw attention to the risk of contamination?—Yes that would be so, anyway as regards the Fishery Committee; it might escape them if they were outside their district.

16395. (*Sir William Ramsay.*) But are they not under some other district?—Not always. I think, for instance, if you take, I think, the river Conway, our district ends at the bridge, but above that there are the fisheries, salmon and sparling, and I believe that mussels are also found above the bridge.

16396. But further up than Morecambe Bay, beyond your jurisdiction northwards, it comes under the jurisdiction of some other Fishery Committee, does it not?—Yes, the Leven; of course, most of these rivers there are salmon authorities, who, if they apply for an order, would have the same powers as a Fisheries Committee.

16397. (*Colonel Harding.*) Can you tell us whether your Fisheries Committee has exercised the powers that under Section 2 of the Sea Fisheries Regulation Act they appear to have to make bye-laws for prohibiting or regulating the deposit or discharge of solid or liquid substances detrimental to sea fish or sea fishing?—Yes, they have agreed to certain places in the estuary of the Mersey for the depositing of the dredgings from the different docks.

16398. You have bye-laws of that kind?—Yes.

16399. Then do they not enable you to prohibit or regulate the deposit or discharge of sewage?—If it was proved to be detrimental to sea fish they would have that power, provided they had no Act; I think it is under the Local Government Board.

16400. If they were acting of course in discharging their sewage and giving it treatment under some Act of Parliament or under some Provisional Order there is a sub-section of Section 13 which would preclude your taking any action, is there not?—That is so, yes.

16401. But in cases where an authority is discharging sewage into the tidal waters without treatment it cannot be acting under an Act of Parliament or a Provisional Order, and, therefore, that exception would not apply. What is there to prevent you from taking action, and, as a fact, have you ever taken action?—No, we have not taken action. The Committee; anyway, it is in their mind that in the case of an old sewer that has been there for some time they would have no power to stop anything that was coming out in any way, but that if a new scheme was brought forward they would have the power to prevent that unless they got a special order from the Local Government Board.

16402. Then, as a fact, have you ever taken any action to prevent the discharge of a new sewer under those circumstances?—No, we have not.

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(*Sir William Ramsay.*) But is it proved that such discharge is dangerous to shell fish; may they not flourish perfectly well in the middle of sewage water?

(*Colonel Harding.*) There is not much evidence, perhaps no evidence, that the discharge is injurious to shell fish, but there is, is there not, sufficiently ample evidence that the shell fish may be carriers of germs so brought down and be dangerous to human beings.

(*Sir William Ramsay.*) Precisely; but the Act does not contemplate that latter possibility.

(*Secretary.*) The Act says: "Detrimental to sea fish or sea fishing."

(*Sir William Ramsay.*) Not to the public health.

(*Secretary.*) "Sea fishing."

(*Colonel Harding.*) In this case it says: "Detrimental to sea fish or sea fishing." Detrimental to sea fishing if it brings about a condition of things which makes the consumption of shell fish dangerous to man.

(*Secretary.*) "Detrimental to the sea fishing."

16403. (*Colonel Harding.*) (*To Witness.*) Anyway, your committee has not taken action under their byelaws under that clause?—They have not, no.

16404. In regard to sewage?—In regard to sewage.

16405. Then, I wanted just to ask you this question: In your district have you any examples of the removal of mussels from their natural habitat to the special laying beds, where they are allowed to develop, and where they may be assumed to purify themselves from any contaminations?—That is done in some cases by fishermen themselves. They take mussels from a portion of an estuary, and replant them in a different part of the river for the purpose; they call it storing mussels. They thrive much better, and then they are sent to market from there.

16406. And that appears to your committee to be a good plan?—It does, yes.

16407. Is there any instance of it on the Wyre?—Yes, sir, they do it on the Wyre.

16408. What is it?—They take mussels from the lower portions of the Wyre, and they place them higher up the river above the oyster beds.

16409. Would not that appear to be a safeguard to be very much encouraged by your committee?—They do encourage it as much as they can, but that is not on account of getting them out of the way of sewage; it was simply because the mussels thrive more and become of more value to the fishermen.

16410. (*Dr. Burn Russell.*) Have you any control over cockles?—With regard to size and the method of taking them.

16411. But as to their location, of their thriving?—No, I have never known cockles moved from one place to another for the purpose of growing. We have tried; we did try one or two experiments of getting large cockles from Scotland, and trying them to see if they would thrive on some of our beds, but it was not successfully carried out.

16412. So that you, in that case, could not meet the difficulty, as you met it with mussels or oysters; the production of cockles would go on, and you could only keep them clean by preventing sewage getting access to them?—That is the only way, so far as I know.

16413. (*Colonel Harding.*) In the case that you mentioned of the Wyre we understood that the object of removing the mussels from their natural habitat to this special laying was to enable them to fatten and develop?—That is so.

16414. Is any care taken in the selection of those layings to place them where they shall be free from contamination?—I do not know whether it is intentionally done, but, as matter of fact, where they are laid they are removed; they are not close to any sewers.

16415. They are not?—They are not; they are taken away from the mouth of the river down below, and they are placed higher up on the opposite side, where the sewage comes in from Fleetwood.

16416. So far as you know, they are there freer from danger of contamination?—Certainly.

16417. In that particular case?—Certainly they would be.

16418. (*Dr. Burn-Russell.*) How long is it since you have taken any practical notice of this liability to the communication of disease by shell fish; it is comparatively quite a recent question?—No, I think it is about a year or two ago since I reported about this particular bed at Egremont, of which I was speaking a little time ago, but it is only lately that we have gone rather deeper into the question, that the committee have decided to—rather, the members of the committee—it will, I hope, be passed at the next meeting, to have a thorough examination of all these beds. That has come about, more or less——

16419. Through recent events?—Through the recent oyster scare, and also partly, I think, by the reports of pollution of the Lancaster water, that flows over the mussel beds there. There have been complaints about the beds from the mouth of the Lune.

Mr. Herbert Donnison, called; and Examined.

Mr. H. Donnison.

16420. (*Chairman.*) You represent the Eastern Sea Fisheries Committee?—Yes, my Lord.

16421. Well, would you state the limits of your district, and how far your jurisdiction extends up the various estuaries?—On the north the line is Donna Nook, near the Humber, and on the south Happisburg, about 18 miles this side of Yarmouth—north of Yarmouth.

16422. You take in the Wash?—We take in the Wash and also the rivers; about 60 miles of river.

16423. And how far does your jurisdiction extend up the various estuaries?—The Ouse; it goes as far as Denver, and the next close on to Peterborough, the Welland above Spalding, and the Witham to the Grand Sluice, just above Boston.

16424. What sort of staff have you?—We have a total of 12. We have a steamer and two sailing cutters, and also police on the coast; we are just getting a larger vessel, and a larger staff.

16425. Are you satisfied with the facilities that you have got for visiting places in your district?—Well, that is the reason why we are having a larger vessel to carry on the duty better.

16426. And have you any facilities for chemical or bacteriological analyses?—None at all.

16427. Have you got a medical officer of health who can advise you if you wanted his advice?—No.

16428. Could you give us a brief summary of the following industries in your district, and indicate on the map the distribution of the shell fish beds, layings, etc.: The cockle industry, the mussel industry, the periwinkle industry, and the oyster industry? (*The witness exhibited maps, and indicated upon them the position of the various beds.*) (See Charts VII. and VIII. following page 8.) Have you any reason to know, or to suppose that there are, or have been, any infected shell fish in your district?—I am not aware of a single case of sickness arising from the eating of mussels or cockles or oysters, but I would not say that a case has not occurred.

16429. But there are no cases that you know of?—I do not know of one case.

16430. And has your committee taken any action to protect the shell fish from pollution?—No. The byelaws—we have looked upon them in the past for the cultivation of the shell fish, the protection of the shell fish, and the cultivation. We have thought about the washing of cockles. There is an immense cockle trade done in that neighbourhood. I have known 10,000 tons to be taken from the Wash in a twelvemonth. They are so thick in places on the sands close to the rivers, that I have known each man collect from 30 cwts. to 2 tons in a day's fishing.

16431. How many persons are engaged in the shell fish industry in your district?—Do you include the crab and lobster fishing?

16432. Yes?—And the shrimping?

16433. Yes?—Of course, it is all shell fish.

16434. Yes. Of course, you can only give the number very roughly?—I should say, approximately, 600.

16435. Now, has it been your practice to attend inquiries held by the Local Government Board inspectors with respect to new schemes of sewage disposal?—No.

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16436. And what powers have you got for prohibiting the laying down or taking up of shell fish in your area? Would you be able under the powers which you already have to prohibit the laying down or the taking up of shell fish near to the sewage outfall?—I do not think the authority would cover that.

16437. Has your committee taken any action under the Sea Fisheries Regulation Act of 1888 with regard to prohibiting the discharge of refuse detrimental to sea fish?—We have, but it has been chiefly in the case of anchors and rubbish thrown overboard from trawlers. We have taken steps with regard to the throwing overboard of the sludge taken from the upper portion of the River Witham, and close to the sewage outfalls they have been throwing this sewage right on top of shell fish, on top of mussels and alongside the mussels. We have approached the Boston Corporation on the matter. They state that they have power to do so, that their Dock Act comes into conflict with our powers, and we are in that state; it really requires a test case to know whether we can stop them or not.

16438. (*Sir Michael Foster.*) You have not had such a test action?—No, we have not.

16439. (*Chairman.*) Have you any control of places in your district where shell fish are washed and boiled and prepared for market?—Well, the mussels and cockles are really washed at sea in the pure water, but in many cases in taking them from the boats they are just dipped in the water; that is close to the outfalls or near the town at Boston and also at Lynn. But the boiling of the cockles is really done in the fresh water of the town; it is only the shell which is washed in the river—in the river water.

16440. You have no control over where they wash them?—Not at all.

16441. (*Sir Michael Foster.*) You said, I think, that these cockles were washed in the river at Boston, just close below the town?—Yes, that is so.

16442. Where the river was very largely polluted with sewage?—Yes.

16443. And you have no power whatever to prevent that?—No.

16444. Then you said, I think, that a very large number of mussels, I forget how many, were taken from various parts of the Wash and laid down on the Norfolk coast outside Brancaster Staithe and Wells?—That is so.

16445. How much annually?—We estimated it at 1,000 tons.

16446. You estimated it at 1,000 tons annually?—We had a meeting; in that part of Norfolk the laymen asked for more brood mussels from the beds, and the men at Boston and Lynn and other places objected to the quantities going to the layings; they wanted them to lie until they became sizeable before they went to the other men; and at that meeting of laymen at Wells they asked for 2,000 tons of mussels a year, but I put the average quantity taken from the Wash at 1,000 tons yearly.

16447. And that is laid down in these layings along the coast there, in some cases in close proximity to a sewage outfall?—Yes, they are only very small places, perhaps 2,000 or 3,000 inhabitants, but in the case of Wells——

16448. There is a considerable population?—The drains go right—you can say above the mussels.

16449. It flows really on to the mussels?—On to the mussels.

16450. Is that the only place there which is suitable for laying the mussels, just this part where the sewer outfalls occur—are there not several other places along the coast quite free from sewage outfall?—Well, the cultivation is carried on in all the harbours along the coast at Thornham, Brancaster, Overy Slaithe, Wells, Blakeney, and Stiffkey, and I am only aware of Wells where there is any danger of pollution. The other layings are further away from the town, more in deep water, and entirely away from the sewage.

16451. Was the laying there before the sewage outfall, or have the layings been placed there since the sewage was discharged from Wells?—Wells is a very old town, and I should say the sewage has always run there.

16452. But the sewage system is probably new—relatively new at Wells, is it not; they had cesspools and all that kind of thing in the old times; when did the laying begin at Wells, do you know? Is it very old history, when the layings began at Wells?—Yes, it is a very old industry.

16453. Probably before the sewer was constructed at Wells to carry the sewage into the sea?—Many years ago—40 or 50 years ago—the cultivation was chiefly oysters, and when the oysters became scarce along the coast, they went into the mussel industry.

16454. And the mussel industry is a profitable industry now?—Fairly profitable; men get a living; they spend practically the whole of their time in the cultivation of the mussels.

16455. One thousand tons is a considerable mass of mussels, is it not?—Well, at Wells alone we have mussels a mile along the harbour, and the harbour authority receive in rent £100 yearly, the rent of these layings.

16456. And except for a small portion these mussels are distributed throughout the country for food?—Yes, the only exception is the local bait demand, the places quite near; the other goes entirely for food.

16457. I see in a paper which has been distributed to us that you say that the discharge of crude and other injurious sewage into the sea or river should be discontinued where it is possible to do so?—Yes, I think so, but I was going to add that I think it is more in the case of additional sewage works. For instance, at Boston they are thinking of spending £15,000 on improving the sewerage works, and they are going to make use of the "Shone" system in getting the sewage along, and then it will be discharged into the river in the same way as it is at the present time, and, in my opinion, I think the authorities should go to additional cost and filter the sewage.

16458. You spoke of the sludge from the river mixed with a good deal, I suppose, of sewage deposit?—Yes.

16459. Being thrown upon the beds?—That is so.

16460. There I suppose it is mechanically injurious, is it not; it smothers them?—Well, the sludge smells, oh! very bad; I have known cases in which the men have not been able to work amongst it.

16461. Do you think that sewage itself is injurious to the shell fish?—I should say so.

16462. What evidence is there of that? Just a little while ago we had evidence that the mussels in a certain locality, after the sewage was formed, gathered round the sewer; is there any evidence that ordinary sewage is injurious to the shell fish themselves?—No; I do not think so to mussels. I have not thought that much about it.

16463. Or to any shell fish?—Mussels will live almost anywhere.

16464. But your sludge, will that interfere with your mussels?—If it is thrown on top of them.

16465. Yes, because it smothers them?—Yes.

16466. It merely acts mechanically?—Yes, that is so; I thought you meant from the point of pollution.

16467. But otherwise, we have no evidence, have we, that the sewage is injurious to the shell fish themselves?—Well, in the case of the mussels, yes; it would choke them if you had much sewage going over the place.

16468. That is to say, if there was too much solid matter in suspension they would get choked?—Yes.

16469. But short of that, we have no evidence that diluted sewage, for instance, which does not mechanically choke the gills of the mussels or of the oysters, we have no evidence that that is injurious to the oysters or the mussels themselves?—I am not aware of any.

16470-1. On the contrary, they feed on a certain portion?—Yes; mussels in particular; mussels, you know, soon make a bed on ground perhaps of hard sand.

16472. So that if you are cutting off from the flow of sewage into the sea, into the estuary, you are depriving these poor creatures of their food to a certain extent?—I do not think so; they certainly fatten.

16473. I mean, if they do, as there is a certain amount of evidence that they do, feed on, at all events, a certain portion of the sewage, then provided the sewage is not of such a quality that mechanically you say it chokes the mussels, they are thriving upon the sewage?—Yes.

16474. And is that not really part of the general economy of nature that they and other animals feed upon the sewage, and the sewage is returned to us through them?—Well, the mussels live in pure water where there is no sewage at all.

16475. They will do that?—And they are very good fish, too.

16476. They will do that; they get other nourishment, but there appears to be evidence that the sewage does serve as nourishment for them, and unless you have clear evidence of other injurious effects in depriving them, as you propose to do, of all sewage, because, apparently, you are recommending that the discharge of sewage into the sea or rivers should be discontinued?—Yes.

16477. You are depriving them, as I say, of a certain quantity of their food?—I do not think so. Close to these rivers where shell fish improve so rapidly, there is a lot of nutriment which comes from the land, and from the drains. You get, no doubt, a lot of life in the water, apart from the sewage, which comes from these drains running from the country. Then there is the drainage from the land, with, perhaps, manure and other things, and then also on the bottom is coated weed and also different life.

16478. I am not suggesting that they live on sewage alone, only that there is a certain portion of the sewage which is available for the nutrition of these animals, and, therefore, there may be an objection to removing the sewage from them altogether, giving them no opportunity whatever of getting the sewage. I understand that you are very clear that sewage, in a certain condition may mechanically choke the shell fish?—Yes.

16479. And it is sewage in that condition that you are most strongly objecting to?—Well, we object to both kinds; we object to the crude sewage. We are not of opinion that the sewage does this. We know it fattens the mussels.

16480. You know that it fattens the mussels?—There is not the slightest doubt, but, at the same time, they will fatten on other things near the mouth——

16481. You say they fatten on it?—For instance, outside the Welland, which I have mentioned, we consider there is no sewage at all coming down from the Welland, and the mussels are fatter there than they are below the Boston river, where the sewage does run down, but that is owing, perhaps, to the land drainage, and also to the nature of the bottom. It is surprising, the difference.

16482. Probably the land drainage there supplies some of the material that is also present in the sewage?—We look upon the nature of the bottom more than anything else.

16483. Quite so, but I am only trying to point out that, although it is very obvious from what you have said that sewage in a certain condition may be directly injurious to the shell fish, interfering with their gills and choking them in that way, there is no adequate evidence that otherwise sewage in a certain condition is injurious to them; indeed, there is a certain amount of evidence that they feed upon that, and flourish upon it, as you yourself said they fatten upon the sewage?—Yes.

16484. So that it is not against all sewage that your contention ought to be, but against sewage under certain conditions?—Well, I am trying to refer to the health point, not to the mussels.

16485. You mean to the health of man?—To the health of man.

16486. Quite so; well, how is the health of man affected by these shell fish being subject to sewage contamination?—Well, I can only follow the evidence given.

16487. It is not that the shell fish themselves are unhealthy, I think, is it; the shell fish themselves are not rendered unhealthy by the sewage, but there are certain germs carried down in the sewage which, though not injurious to the shell fish themselves, remain in the shell fish?—Yes.

16488. And are carried from the shell fish to man?—To man.

16489. Cause disease?—Yes, that is so; that is our view.

16490. You have repeated here your phrase, "crude sewage"; you seem to object to crude sewage much more than to treated sewage?—Yes, we do.

16491. Well, but that treatment, in order to prevent the sewage being injurious to man through the shell fish, must be carried so far as to remove all the germs of disease?—Yes.

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16492. Ordinary purification of the sewage would simply remove a great deal of the solid matter in suspension?—Yes.

16493. But allow the germs still to be in the sewage; that treatment would not prevent the oyster bed being a means, or the mussel bed being a means, of disease to man, so that you want, in order to keep the mussel bed or the oyster bed completely free from the possibility of conveying disease, you must have complete treatment of the sewage; destruction of all the germs in it?—As far as I understand the treatment of filtration of sewage, it destroys the micro-organisms in the sewage—destroys many of the germs. I am not speaking from any authority; that is the view I have taken.

16494. That is your view?—Yes.

16495. You require the germs should be destroyed, and you understand that the ordinary filtration processes do destroy those germs?—That in addition to running down stream and other natural things.

16496. So that if it were proved that those systems did not destroy the germs your confidence in the treatment would be shaken?—Yes, but I am not aware of the sea water being dangerous if taken from any distance.

16497. That is another matter coming in; quite so. Your committee has apparently very limited power?—Yes.

16498. And you think those powers should be increased?—Yes, I do.

16499. To what extent, and in what way?—Well, it has been really the business of the committee, as I have already pointed out, to protect the fishing, but if they had any mind to also protect the health of the community by prohibiting the taking of shell fish near sewer outfalls I consider it would be beneficial.

16500. That power you have not at present?—No.

16501. You do report, I suppose, to sanitary authorities all such cases; have you done so?—No.

16502. You have not done so at all?—Not the improvement in the sewerage. Any alteration in the sewerage is submitted to us at the present time by the Local Government Board, and I have made inquiries at the different places whether there is danger or not. The other week I made a report about an extension of an outfall at Hunstanton, close to shell fish beds.

16503. You made that report to whom?—I made that report to my committee.

16504. To your committee; what use does your committee make of that report?—Well, if it was a very bad case they would simply bring the matter forward to the Local Government Board.

16505. And you think that your committee ought to have power to close down beds which are injurious to human lives?—Yes.

16506. (*Dr. Burn Russell.*) Have you any experience in your district of the influence of manufacturing sewage on shell fish?—No.

16507. It is chiefly domestic sewage?—Ordinary domestic. There are very few manufacturers, very few factories, either at Boston or Lynn. I am not aware of anything coming from them that is detrimental to shell fish.

16508. I suppose the food of these shell fish, or a certain species of them, is very largely something that is invisible to us, in what seems to us to be pure water?—I do not think we know so much as we should do about the requirements of the shell fish.

16509. What is the result of the transplanting of those mussels to the Norfolk coast; do they multiply and increase in size?—They do not multiply, not in those waters, but they increase in size very rapidly, and they are also well fished; they are full of fish inside.

16510. Can you express in weight the difference between the shell fish that are placed there and the export for use throughout the country. I thought I heard you say that they increased in weight three or four times?—Yes; well, quite that. It really depends upon the size. A mussel from 2in. to 2¼in., I think, half doubles itself in weight in the ¼in.

16511. So that if you put 1,000 tons of small mussels, down, the result is several thousand tons?—Yes; it is very difficult to arrive at the quantity. Of course, there is a loss from natural causes by stoms and by choking, and one thing and another, but you could

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put it every 1,000 tons would be quite 4,000 or 5,000 tons.

16512. Do you know whether they are cooked in any way before being eaten?—I believe in nearly all cases.

16513. Cooked?—Yes.

16514. Boiled?—Boiled.

16515. I think you used the words "blue mussels," did you not?—No.

16516. It must have been an error in my hearing?—I do not know of any.

16517. I thought you used the phrase "blue mussels"?—No. I understand the words "blue mussel"; you sometimes get the blue of the shell with it rolling about on the sand, but I do not think it is generally known as the blue mussel.

16518. (*Colonel Harding.*) The district that your committee is connected with turns out an enormous quantity of shell fish?—Yes, enormous.

16519. Can you tell us how many cases there have been within the last 10 years where there have been outbreaks of epidemic disease alleged to be due to the consumption of shell fish in your district?—I am not aware of one case.

16520. You are not aware of any case?—No.

16521. Do you suggest to us that in connection with mussels the danger is much less likely to arise than in connection with oysters, because the mussels are always cooked?—Well, they are boiled very lightly; in the case of cockles they are only just steamed open.

16522. But in the case of mussels they are more thoroughly cooked than cockles generally?—Than cockles generally, yes.

16523. And you would be prepared to find there would not be the same danger from the eating of mussels than there would be from the eating of cockles?—I should say that there would be a like danger, and quite as much as from oysters.

16524. Although you say the mussel is generally more thoroughly cooked, you still think that there would be danger?—Yes.

16525. But as a fact, in your district you are not aware within the last 20 years of any outbreak of epidemic disease which has been alleged to be due to the consumption of mussels?—I am not, but I would like to add that the poor people eat mussels, and I do not think a case of death from eating mussels has been traced so well in the past as it has been with oysters.

16526. You think that it is exceedingly likely that deaths from disease may have arisen without being directly connected with the consumption of those shell fish?—That is my opinion.

16527. Now, you told us that you had taken some action in one case against an authority which was turning out sewage, but that they were protected by some big Act?—Yes.

16528. Now you have powers under Section 2 of your Act to make bye-laws against the introduction of liquid matter or sewage in your district, have you not?—Yes.

16529. Where such matters are found to injure the sea fish or sea fishing?—Yes, that is so.

16530. Well, you would consider, would you not, it was an injury to the sea fish if during the outbreak of disease the consumption of the fish was largely reduced?—Yes.

16531. Have you in fact ever taken any action in such cases where the parties have not been protected by an Act of Parliament or by a Provisional Order; have you ever taken any action to prevent the discharge of sewage?—I already pointed out I am not aware of a single death from eating these mussels.

16532. So that you have not had occasion to take any action?—We have had no occasion; it is only at the present time that the Corporation have been dumping the sludge on top of these mussels, the fishermen objecting, and also knowing the danger or thinking that there is danger in this sludge.

16533. In that case you thought it necessary to take action?—In that case we thought it necessary, and that is the only instance in which the committee has taken action.

Letters Subsequently Received from Mr. Donnison.

Eastern Sea Fisheries,
Boston,
2nd March, 1903.

Dear Sir,—In my evidence I mentioned the advisability of Fisheries Committees protecting the public from impure shell fish.

It is only right to point out that the maritime counties alone pay the expenses of the committees, and that the county councils concerned bitterly complain at having to do so. In some cases the county council representatives have been instructed to oppose the proposed expenditure of the Fisheries Committee. The present arrangement is certainly unfair, as a fish supply affects the whole country. A Fisheries Committee, in my opinion, would be a suitable authority to safeguard the public against polluted fish, but the cost should be made a national one.

With regard to the fact that some sewage will fatten shell fish, I would like to mention that none of it, so far as I am aware, will quicken the growth of shell. A strong current affects growth of shell very much, and in some cases the fish as well. A short time ago I took some mussels from a channel buoy, which had been down exactly two years, and they were 3¼ inches in length. On some of the beds a two year old mussel does not exceed 1½ inches in length. I could give many instances of rapid and slow growth of shell and of the fish inside, quite apart from sewage.

In January, 1899, there was a leakage of creosote in one of our rivers. Soon afterwards complaints were made in the inland towns about mussels and cockles, which were thought poisonous. No one was hurt, but the alarm became so general that the press took note of it. This illustrates how fish are affected by what is in the water.

I should like you to mention the aforegoing to the Commissioners.

Yours obediently,
H. Donnison.

F. J. Willis, Esq.,
Secretary.

Eastern Sea Fisheries,
Boston,
March 14th, 1903.

Dear Sir,—I am sending by this post duplicates of charts as desired.

The chart of the Wash shows our mussel scalps (marked blue), and cockle beds (marked red). There are many other places from which these fish are taken in less quantities.

I visited a cockle bed about a month ago, and measured a square foot of average ground. In this space I found over 1,000 brood cockles. The bed was roughly one mile in length by one-third mile in width. This will give you some idea how thickly they sometimes lie in the sand.

Periwinkles are mostly obtained from mussel beds.

Oyster fishing with us is of no importance.

The principal whelk grounds are situate off the Norfolk coast. There are also some good grounds in the lower portions of the Wash.

Yours faithfully,
H. Donnison.

F. J. Willis, Esq.,

(*See* Charts VII. and VIII. and Photographs below.)

Handed in by Mr R. A. Dawson.

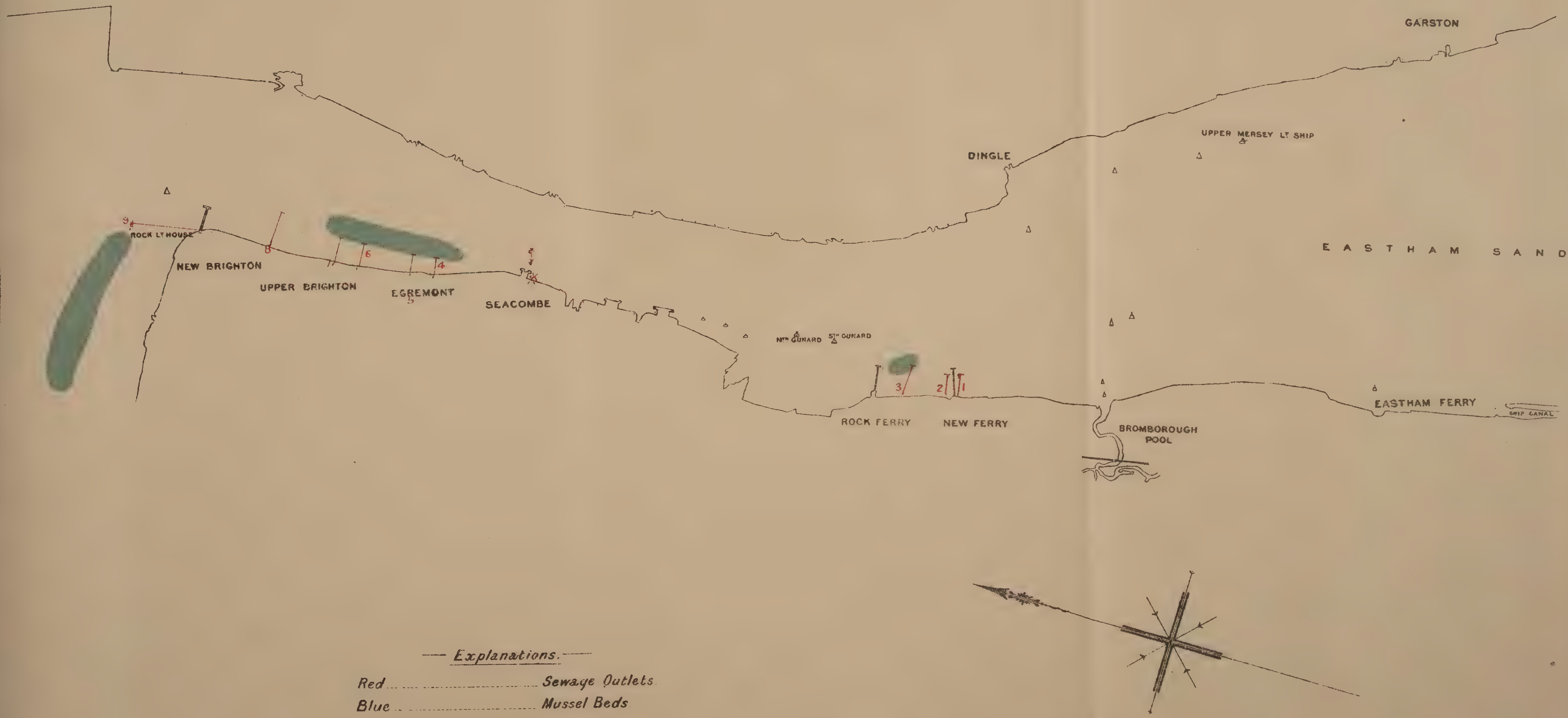
Chart I.

RIVER MERSEY.

FROM

ROCK LIGHTHOUSE TO EASTHAM AND GARSTON.

1901.



Explanations.

Red .... Sewage Outlets

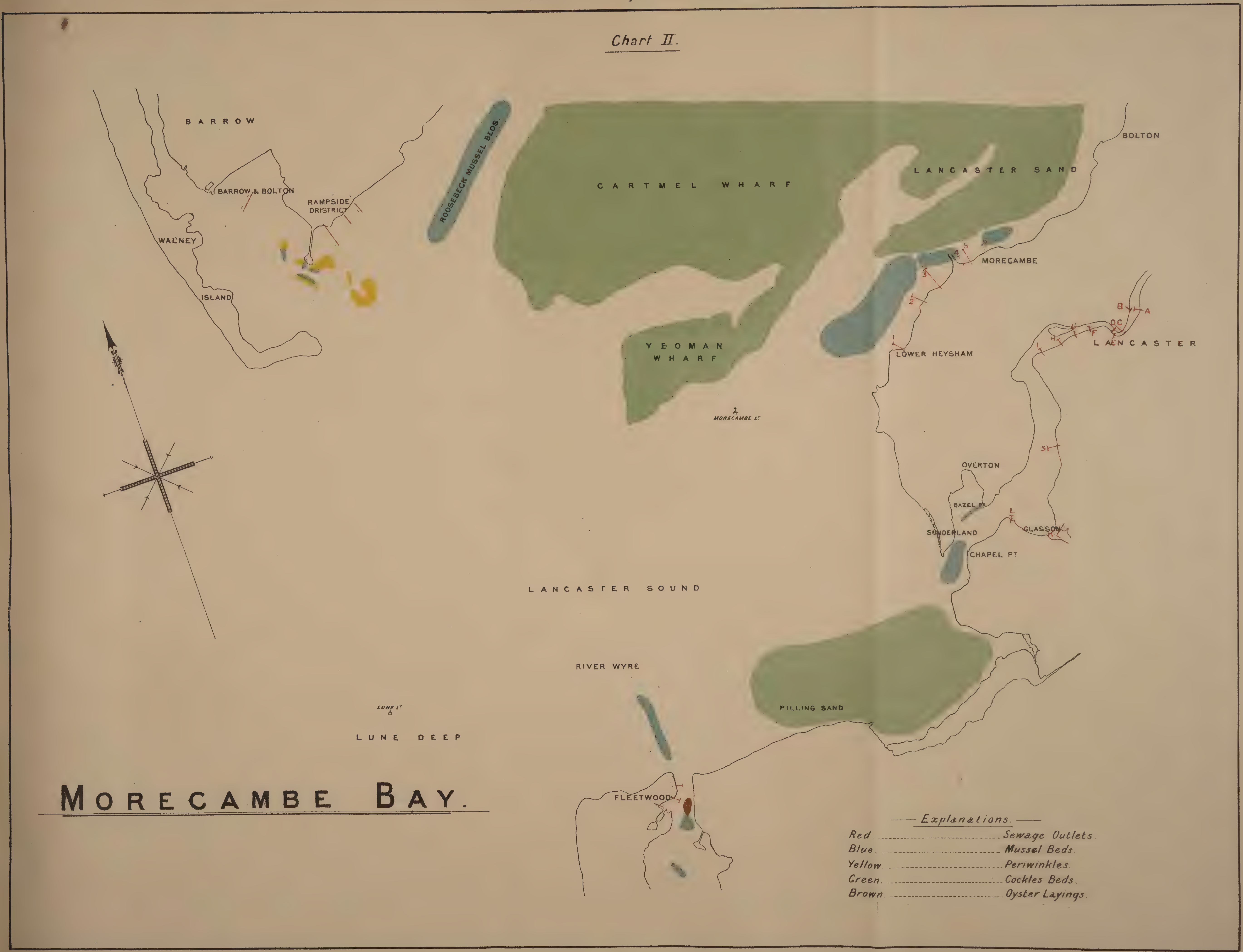
Blue .... Mussel Beds

3311. 5. 03.

Weller & Graham, Ltd Litho. London.

Handed in by Mr R. A. Dawson.

Chart II.



MORECAMBE BAY.

3311. 5. 03.

Weller & Graham, Ltd Litho London.

Handed in by Mr R. A. Dawson.

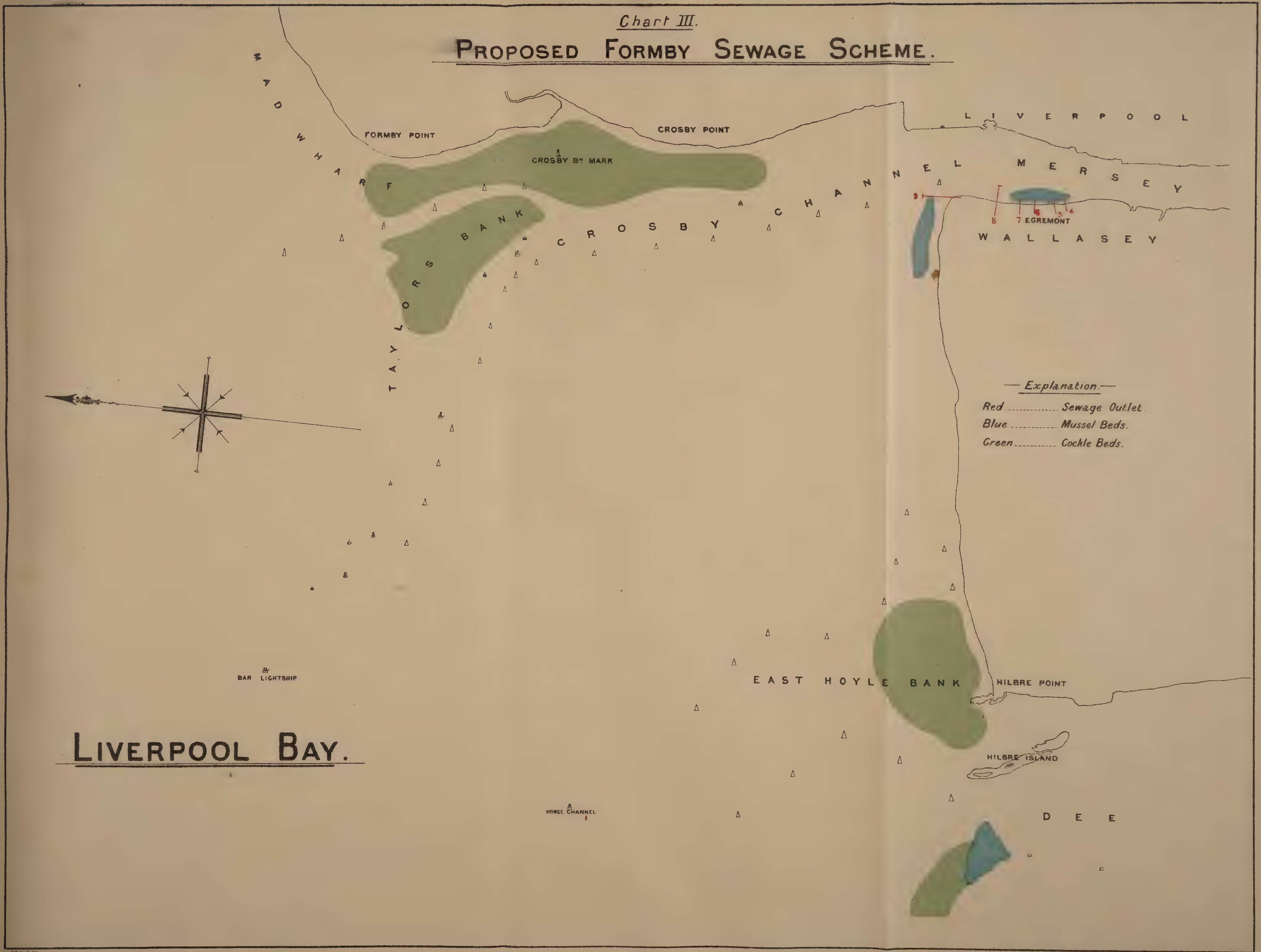


Chart III.

PROPOSED FORMBY SEWAGE SCHEME.

3311 5 03

Weller & Graham, Ltd Litho, London.

Handed in by Mr R. A. Dawson.

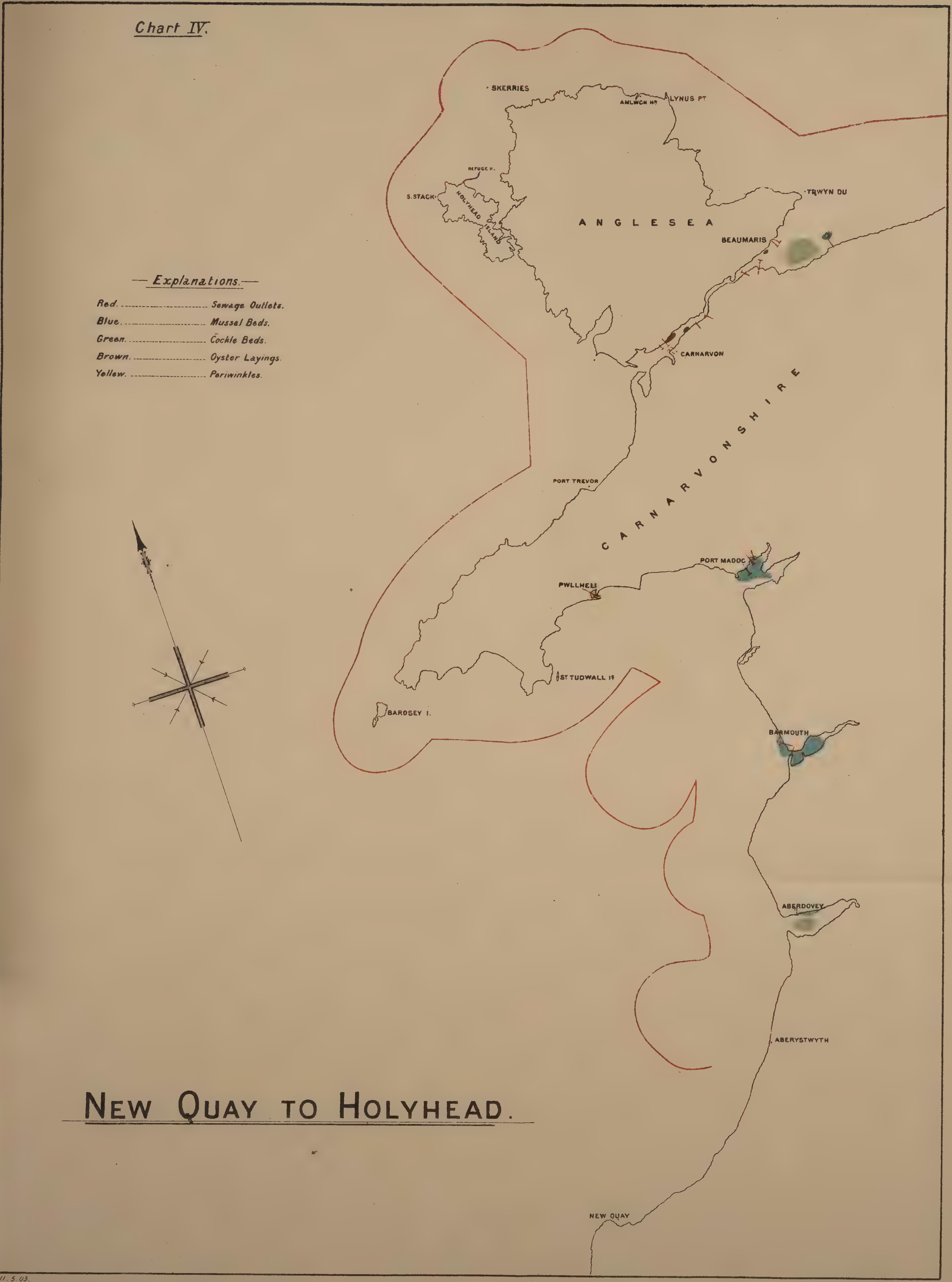


Chart IV.

— Explanations. —

Red.	Sewage Outlets.
Blue.	Mussel Beds.
Green.	Cockle Beds.
Brown.	Oyster Layings.
Yellow.	Periwinkles.

NEW QUAY TO HOLYHEAD.

3311. 5. 03.

Weller & Graham, Ltd Litho London

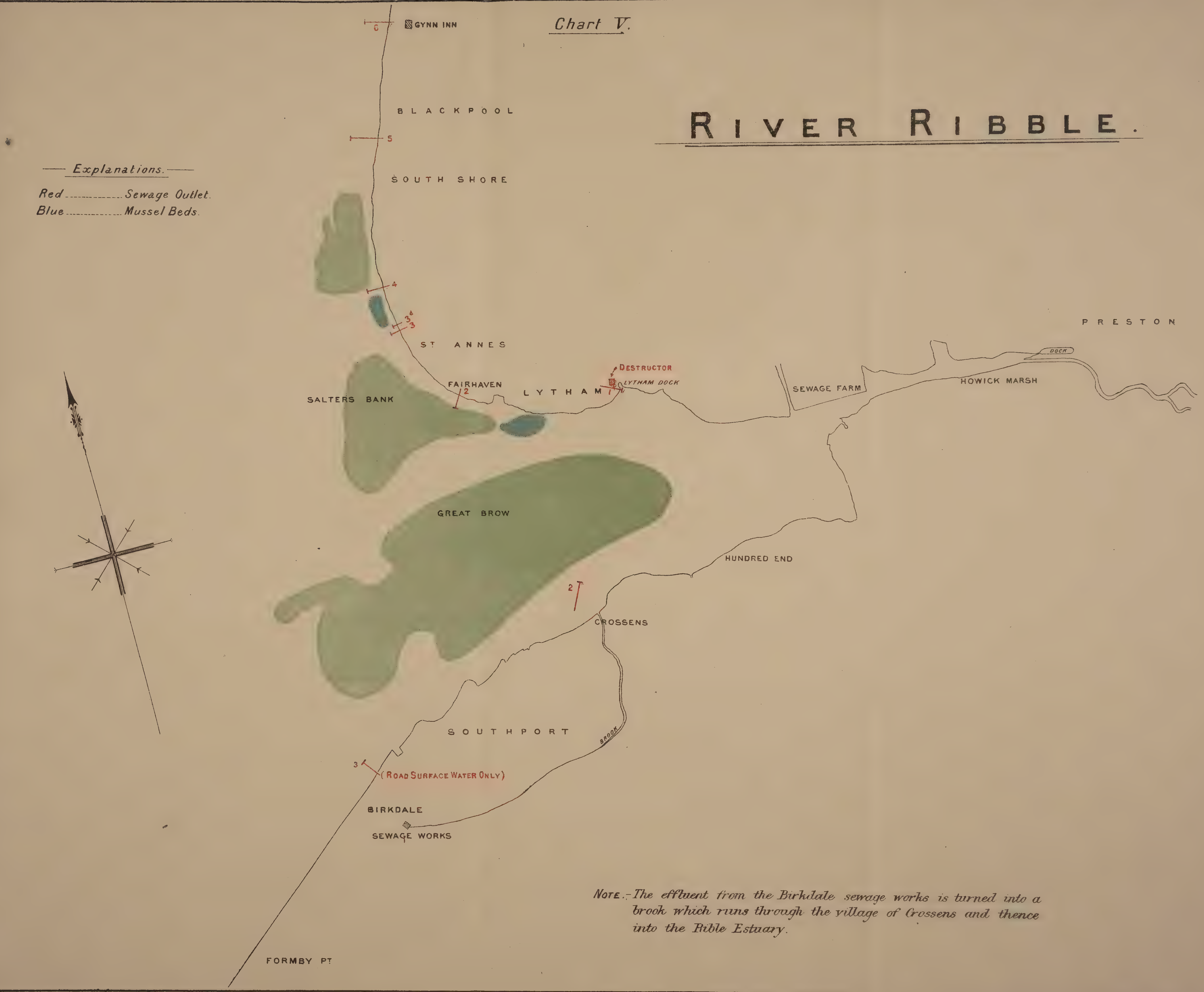
Handed in by Mr R. A. Dawson.

Chart V.

RIVER RIBBLE.

Explanations.

Red .... Sewage Outlet.
Blue .... Mussel Beds.



NOTE.—The effluent from the Birkdale sewage works is turned into a brook which runs through the village of Crossens and thence into the Ribble Estuary.

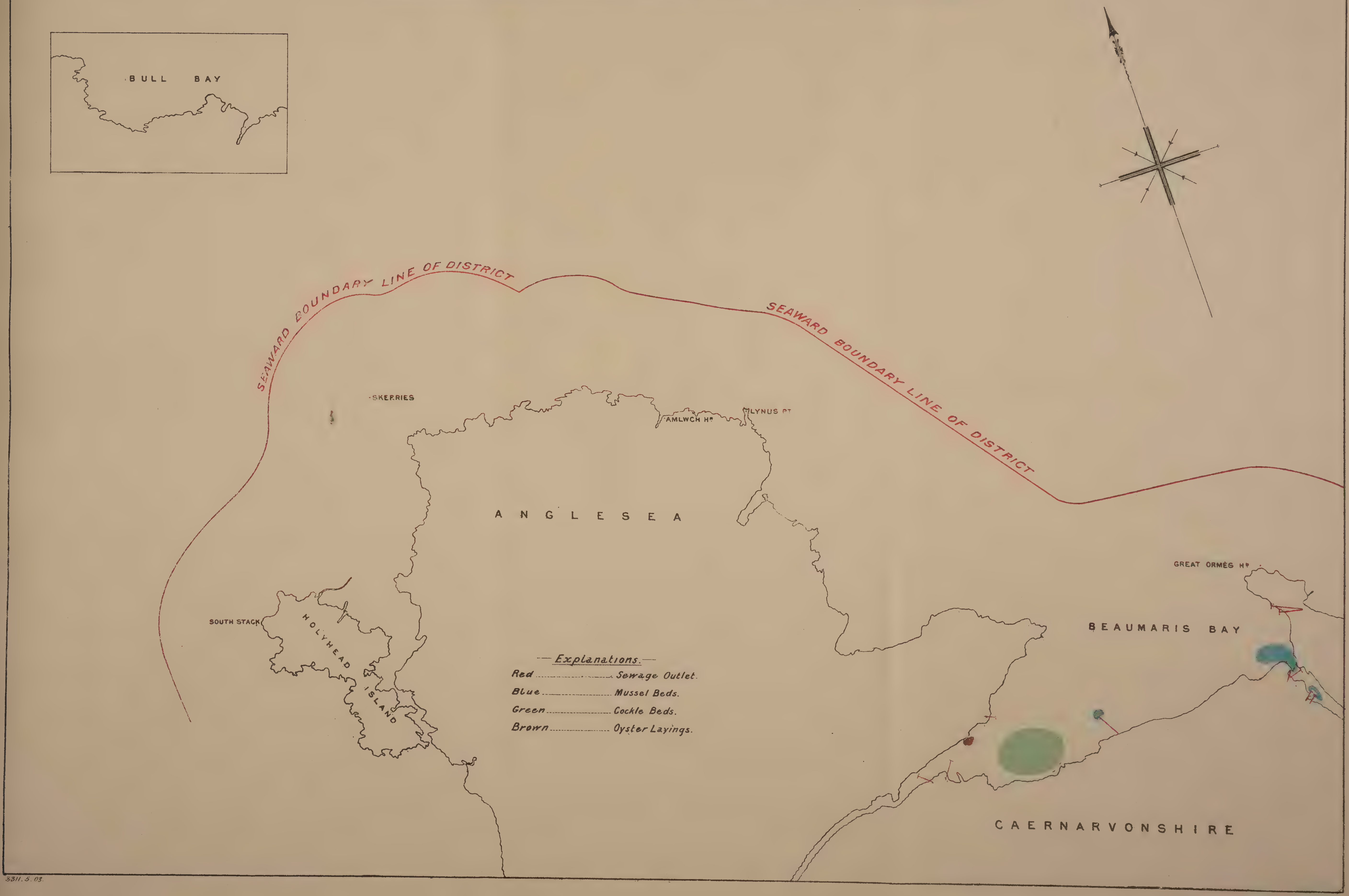
3311 5.03.

Weller & Graham, Ltd Litho. London.

Handed in by Mr R. A. Dawson.

Chart VI.

HOLYHEAD TO GREAT ORMES HEAD.

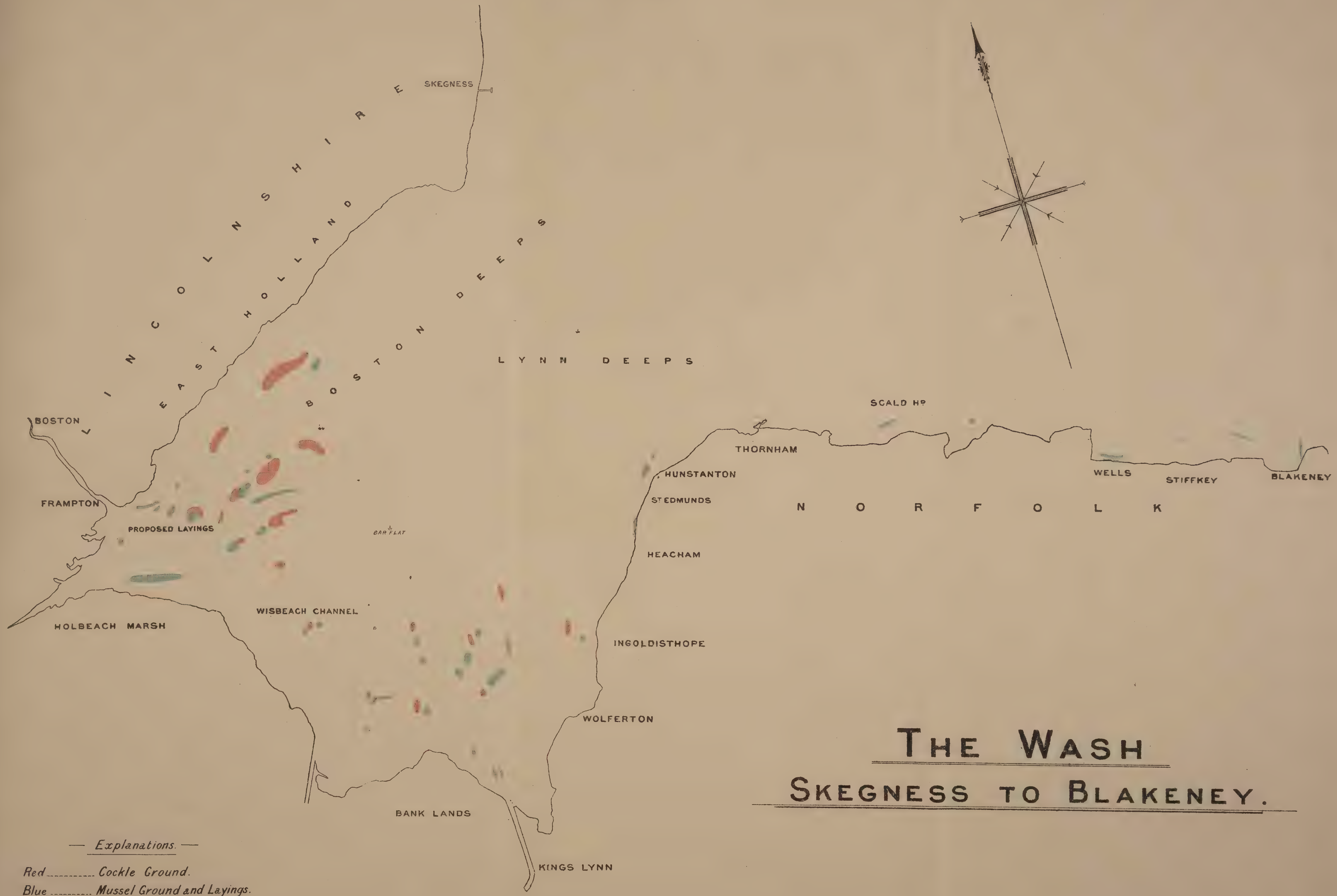

BULL BAY
SEAWARD BOUNDARY LINE OF DISTRICT
SEAWARD BOUNDARY LINE OF DISTRICT
SKERRIES
AMLWCH Hr
LYNUS PT
ANGLESEA
SOUTH STACK
HOLYHEAD ISLAND
GREAT ORMES Hd
BEAUMARIS BAY
CAERNARVONSHIRE
Explanations.
Red .... Sewage Outlet.
Blue .... Mussel Beds.
Green .... Cockle Beds.
Brown .... Oyster Layings.

3311. 5. 03.

Weller & Graham Ltd Litho. London.

Handed in by Mr H. Donnison.

Chart VII.



THE WASH

SKEGNESS TO BLAKENEY.

— *Explanations.* —

Red ……… Cockle Ground.
Blue ……… Mussel Ground and Layings.

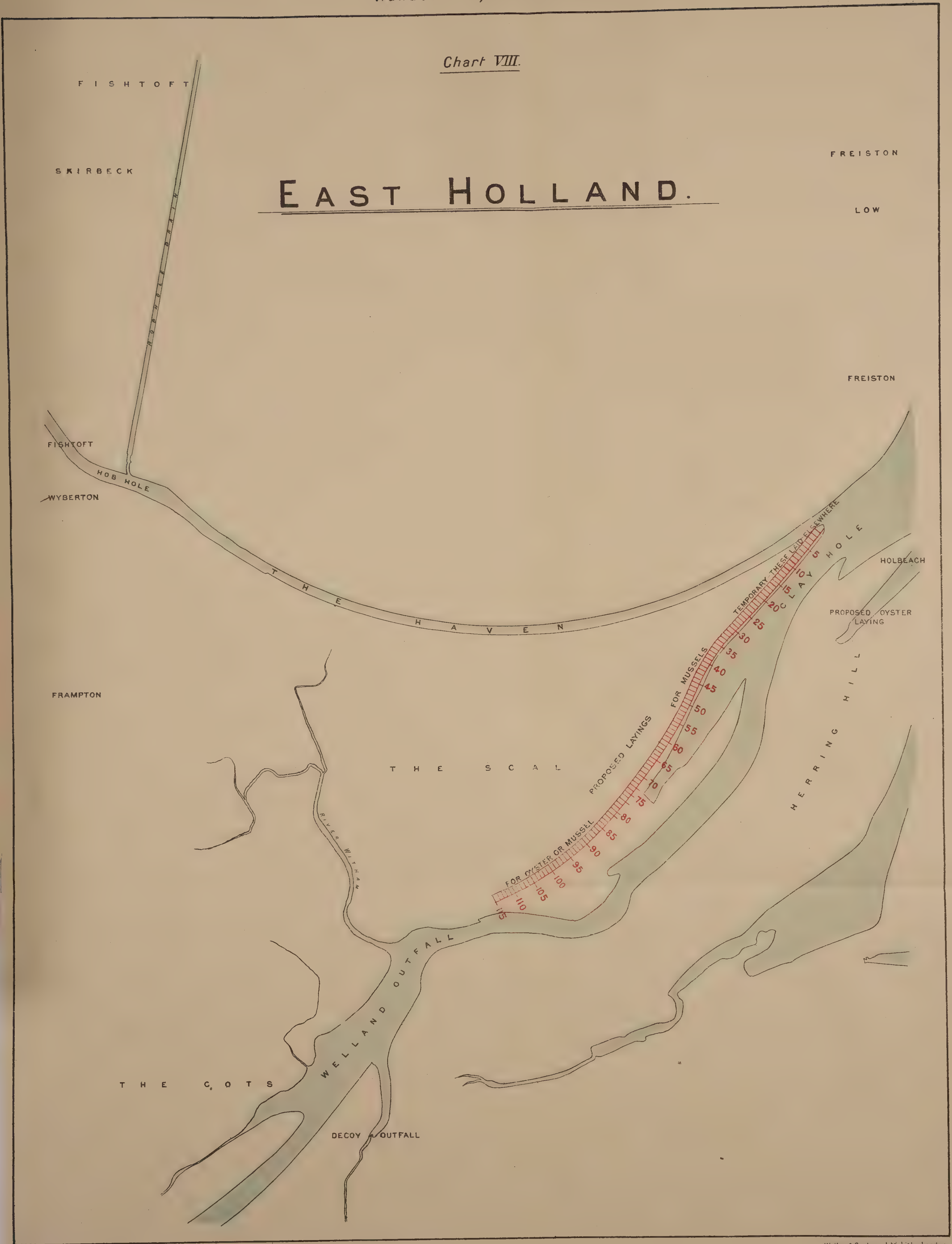
3311. 5. 03

Weller & Graham. Ltd Litho. London

Handed in by Mr H. Donnison.

Chart VIII.

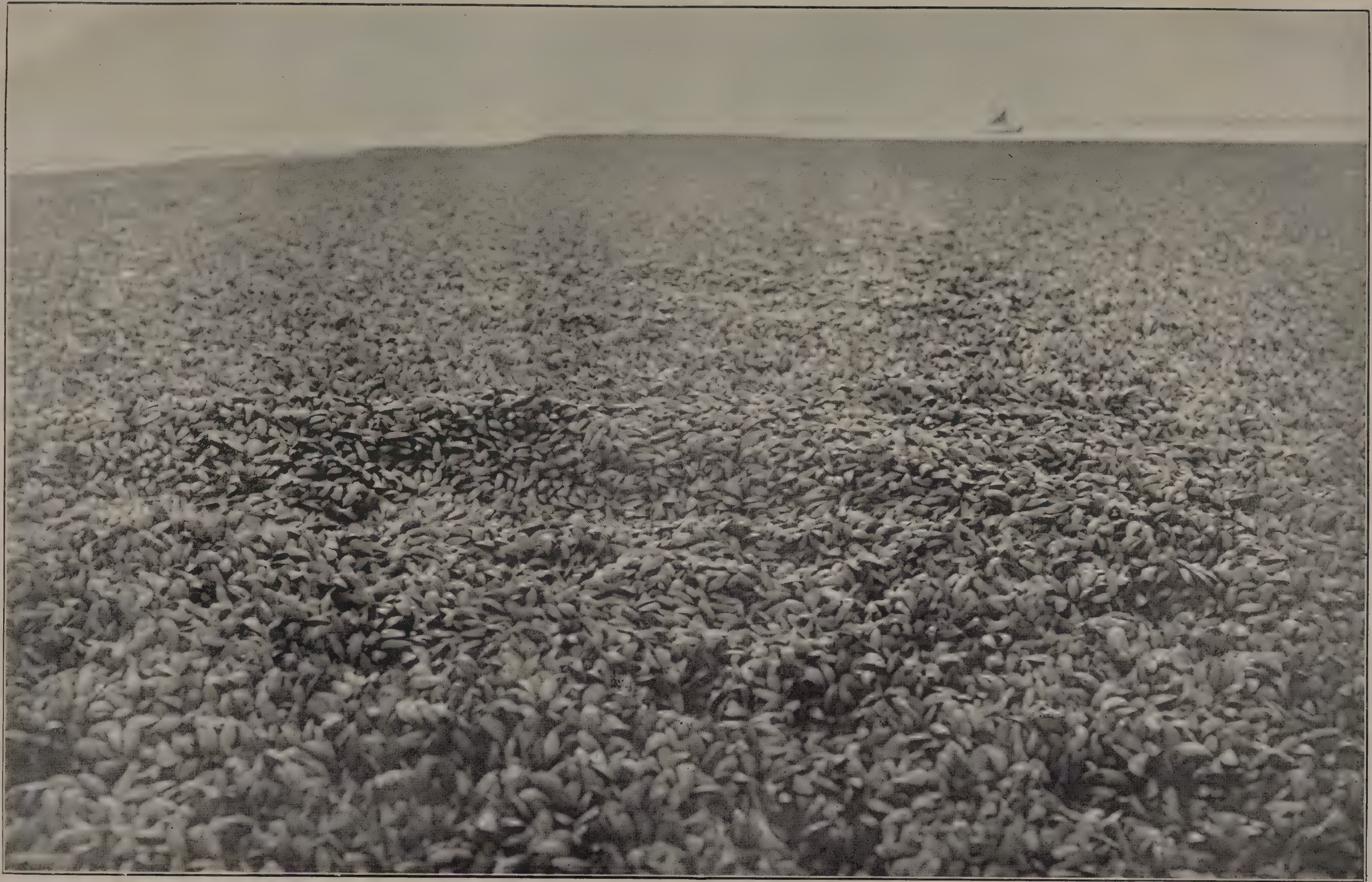
EAST HOLLAND.



3311.5.03.

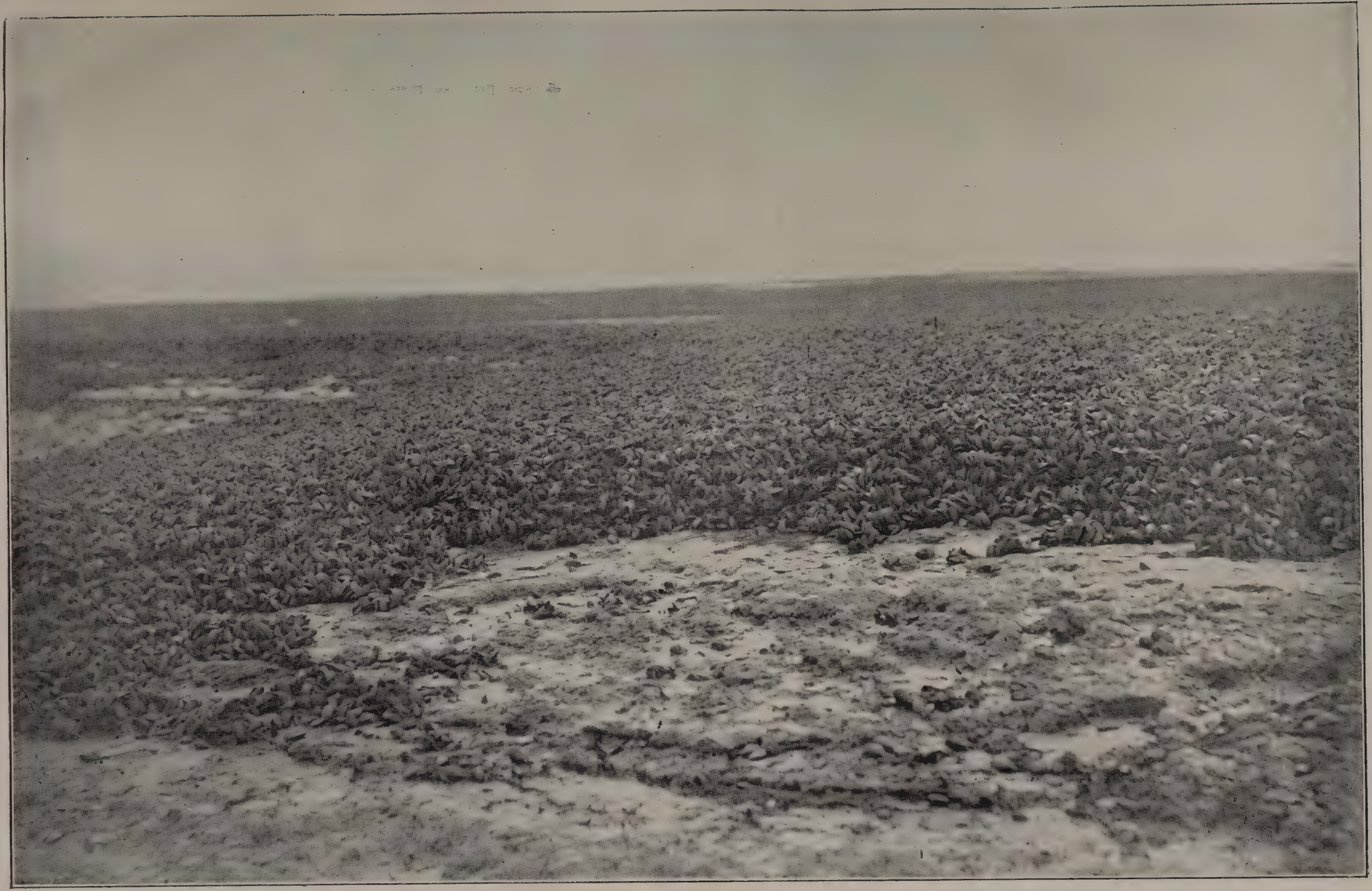
Weller & Graham, Ltd Litho London.

PHOTOGRAPH HANDED IN BY MR. H. DONNISON.



PHOTOGRAPH OF MUSSEL BEDS, SHOWING QUANTITY.

Photograph handed in by Mr. H. Donnison.



Photograph of Mussel Beds, Showing Depth.

FIFTY-SEVENTH DAY.

Wednesday, 25th February 1903.

PRESENT:

The Right Honourable The Earl of IDDESLEIGH (*Chairman*).

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P.
Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General C. PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, C.B., F.R.S.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT—

Dr. A. C. HOUSTON.
Dr. BULSTRODE.

Mr. HERBERT WILLIAM GIBSON, called; and Examined.

Mr. H. W. Gibson.
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16534. (*Chairman.*) You come before us representing the Kent and Essex Sea Fisheries District?—Yes.

16535. Well, now, would you tell us the limits of your jurisdiction?—The Committee was formed under an Order of the Board of Trade in pursuance of the Sea Fisheries Regulation Act, 1888, and the limits of the district are practically from Dovercourt to Dungeness, but lines are drawn across the mouths of certain rivers. A line is drawn across the mouth of the River Colne and also across the Medway, but otherwise the district practically covers the whole of the coast of Essex and Kent.

16536. Then, with those three estuaries that you have mentioned your jurisdiction does not extend far?—No, in the Thames we come just about to Leigh. Leigh is just about the Thames Conservancy jurisdiction, and a line is drawn from the "Crow Stone" to the London Stone on the other side.

16537. Now, what authorities do have jurisdiction over the waters of the Thames, the Medway, and the Colne?—In the Colne practically, I think the Corporation of Colchester.

16538. (*Sir Michael Foster.*) The whole of it?—Practically the whole of the Colne. Yes, and in the Thames the Thames Conservancy Board, and in the Medway there is a Medway Conservancy Board, I believe.

16539. (*Chairman.*) Do you consider that your own jurisdiction ought to be extended up those rivers?—I should say not.

16540. And what jurisdiction have you got over the waters of the Crouch and the Roach?—As regards the Crouch, Roach, and the Blackwater, we go right away up the tidal portions, miles of each river.

16541. And have you exercised any jurisdiction there?—In those rivers?

16542. Yes?—Yes, we have prosecuted—well, in two rivers for breach of the bye-laws; for taking fish in the close time.

16543. (*Sir Michael Foster.*) Which were those?—In the Blackwater there was a prosecution near Maldon, and in the Crouch there have been prosecutions near Burnham.

16544. How near Maldon does the tide go up in the Blackwater?—It is tidal just above Maldon, I think, sir.

16545. Above Maldon?—Yes.

16546. (*Chairman.*) Does your jurisdiction extend to storage beds or ponds on the foreshore or the shore?—I should say not. The Sea Fisheries Act excepts private rights to fish, etc., and no doubt storage beds are private rights, but we have done what we could to watch oyster beds which might be polluted, and also to get improper storage beds removed.

16547. And, now, could you give us any instance in which you have done it?—Yes, in the Colne, although I am afraid it is outside our jurisdiction. We took the matter up at Wyvenhoe, and we found some storage places which were not satisfactory, and we had them removed.

16548. (*Sir Michael Foster.*) But if you have no rights what method did you take to get them removed at Wyvenhoe?—We used persuasion, sir.

16549. Persuasion?—That was at the time of the previous oyster scare.

16550. (*Chairman.*) What staff have you got?—We have two head fishery officers, one for Kent and one for Essex, and about seven or eight and twenty other officers scattered over the district—fishermen, pilots, and others who communicate with the head officers if necessary, and the head officers communicate with me, and I bring any matter before the committee.

16551. And have you got ample facilities for paying visits to the fisheries when you want to?—I do not think we have; we have considered the question of having a permanent steamer, but it is a very great expense, and we have not got to that yet.

16552. (*Sir Michael Foster.*) You would have it if you could afford it?—Well, we can go to any expense we like. We can draw on the county rates of Essex and Kent, but it is an expense which we do not feel justified at present in incurring.

16553. (*Chairman.*) Have you got any facilities for bacteriological or chemical examination if you want to examine either the fish or the effluents?—Not as a Fisheries Committee. If I wanted assistance as regards the Essex coast, I should go to the Essex Medical Officer of Health, Dr. Thresh.

16554. Have you got a Medical Officer of Health who is officially entitled to advise you?—I do not understand.

16555. Have you got a Medical Officer of Health who is officially entitled to advise you?—No.

16556. Then, if you took to the Medical Officer of Health some fish, and asked him to examine them in a bacteriological manner, he would do it, and he would charge his own expenses to the County Council, or to you?—Well, we have never done such a thing. You see the majority of oyster beds are private property, and though we exercise what jurisdiction we can if things are really wrong there, we look to the private owners to put the matter right at their own expense. I mean we do not, as a matter of fact, take samples of fish from different parts, and submit them for examination, to see whether they are healthy or not.

16557. You have never had either sewage effluent or fish examined either bacteriologically or chemically?—No, except indirectly through the Board of Trade, or by our own county Medical Officer of Health. You see I am also acting clerk to the Essex County Council, so that if there is anything wrong in the Fisheries Committee which I wish to bring forward through the Sanitary Committee of the County Council, I can get it looked into.

16558. (*Sir Michael Foster.*) That is a kind of private information, is it not?—Yes; for instance, we have a report here from Dr. Thresh on the state of the waters

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in the Thames near the outfalls, which I make use of for fishery purposes.

16559. (*Chairman.*) Can you give us a brief outline of the following industries in your district, and indicate on the map their distribution, the cockle industry, the mussel industry, the periwinkle industry, and the oyster industry?—I could do it to a certain extent, not altogether accurately, because, of course, personally I do not visit the dictrict; but dealing first of all with the oyster laying—I may say the marking on that map has nothing to do with my district; it is not an official map of the district, it is one I use for reference.—(*Witness indicated on the map the position of the several bed "layings," etc.*)

16560. What has your Medical Officer of Health done?—He has only done what he has under the direction of the Essex County Council. As county medical officer it is his business generally to see to the health of the county, and as soon as he knew of this last scare—this cockle scare—he went to Leigh and made sundry examinations, and he has also worked his way all up the coast, and looked into the state of the oyster fisheries generally.

16561. Well, then, has he reported on them?—He has in some cases. For instance, at Burnham, that is the Crouch fishery, he has reported that it is comparatively pure. As regards the Thames he has, to a great extent, I think, condemned the estuary altogether as a proper place for shell fish.

16562. Has he reported upon the estuary of the Thames?—He has from time to time reported. He reported on the cockle industry, that the creek at Leigh was more or less polluted. There have been outbreaks of disease from fish taken in and around Southend, and at Whitstable, too, things are not altogether as they should be.

16563. And are those reports public property?—No, not altogether, I think.

16564. Now, will you tell us the number of persons that you estimate are engaged in the shell fish industries in your district?—That I am afraid I cannot do. There is an official return to the Board of Trade every year, which, I think, will be the best means of getting that information; it is incorporated in their Annual Report. It deals with the number of men at each port, but I may say that the oyster industry alone is a most important one, especially in Essex.

16565. And then you would not have any notion as to the approximate value of the fishing industry in your district?—No, because parts of it are in private hands—private companies under grants from the Board of Trade. And then there is the general open fishery, what we call the common grounds; there is a number of oysters there; there is a large large amount of spat there; there is what is called "culch," too, which is valuable, and it is difficult to get any return as regards that.

16566. (*Sir Michael Foster.*) What does it exactly mean—the open grounds; that anyone may go and fish there?—Exactly, say for oysters, or whatever there is there—mussels.

16567. (*Chairman.*) Now have you any reason to suppose, or to know that there are, or have been, any infected shell fish in your district?—There is no doubt about it; I have no doubt whatever.

16568. And have your committee taken any action to protect the shell fish from pollution?—Yes, we have done all in our power; we are considerably fettered by the provisions of the Act of 1888—the Sea Fisheries Regulation Act, which prevents us from making bye-laws prejudicially affecting the power of the sanitary or other local authority to discharge sewage in pursuance of statutory powers. The majority of authorities do discharge sewage in pursuance of statutory powers under the Public Health Act or under private Acts, therefore we can do but little. Wherever any scheme is to be altered, or there is a proposal for a new scheme, the Board of Trade now send it down to us for our comments, and we make our comments upon it, but generally the scheme is approved in the end, because the Board of Trade apparently only have very limited powers. They have to look at the matter from the point of view of the owner of the foreshore, and we have raised certain objections which they try to meet as far as possible, but it is generally a matter of compromise, and the provision very often is that they give their consent provided that the sewage is let out at certain states of the tide, and that certain things are done. Well, those conditions probably reach the authority, but whether they reach the engineer, and whether they reach the ordinary man who is there at the works, is doubtful, and there is probably nothing to prevent the man who is well away from all other dwelling-houses, doing pretty much what he likes there. His business is to get rid of the sewage, our business is to see that it is only got rid of at certain states of the tide. It seems to me very essential that there should be some means of checking this man in his duties.

16569. Has it been your practice in the past to attend Local Government Board inquiries as to sewage disposal when they have been held in your district, and to put before the inspector the conditions as to shell fish distribution in the vicinity of the proposed outfall?—Not as a rule.

16570. And have you any power to register oyster layings, mussel layings, or cockle grounds, to prevent these shell fish being brought or gathered from beds or polluted sources, or to insure that the industry generally shall be conducted on wholesome lines?—To a certain extent. For instance, if there is a public mussel ground which is being polluted we should make a bye law prohibiting the taking of mussels from that bed for a certain time. But if it was a private oyster ground, say, for instance, the Tollesbury Company's ground, we could not make a bye-law there except with their consent, and it is hardly likely that they would consent to have their layings shut up. They would immediately want compensation.

16571. (*Sir Michael Foster.*) The public grounds, I suppose, are only a very small fraction of the total yielding grounds?—I should think so.

16572. The main duties of your committee, Mr. Gibson, are, I see, first, to prevent the taking of immature fish?—Yes, that is one object of our powers.

16573. That, of course, does not concern us here?—But I may explain that the chief object of the passing of the Act of 1888 was to put a stop to the throwing of rubbish into the Thames, old bedsteads, iron, and that kind of thing, which was detrimental to the fishing and to the fishing nets.

16574. But I thought that the establishment of the Fisheries Committees over the Kingdom was mainly directed towards preventing the taking of immature fish, and the premature destruction of fish; is not that so?—I think that followed, but the original movement in the matter was on account of the state of the Thames.

16575. Were you the first Fishery Committee?—I think we were one of the very first districts, and then other districts were created all round the coast.

16576. And the bedsteads were the cause of your existence?—Partly, yes; the refuse that was thrown into the Thames, and thrown in anywhere. We had a number of prosecutions at first, and we came to terms both with the Admiralty and with the London County Council.

16577. So that Clause 2 E of the Act which gives you power to make bye-laws "for prohibiting or regulating the deposit or discharge of any solid or regulating substance detrimental to sea fish or sea fishing." That really was an essential part of your duty?—Exactly so.

16578. But you are exceedingly hampered in that by Clause 13, which you read just now?—Yes.

16579. First of all with regard to the discharge of this refuse perfectly independent from the sewer outfall?—Yes.

16580. That has been a great trouble?—Well, that is dealt with by Bye-law No. 15:—"The deposit or discharge of any solid or liquid substance detrimental to sea fish or sea fishing is hereby prohibited. Provided that this bye-law shall not apply: (1) To the deposit or discharge of refuse by the Lords Commissioners of the Admiralty in the River Thames below the Mouse lightship and near the Mouse Sand; or (2) to the deposit by any other person with the consent in writing of the committee given under the hand of their clerk, and confirmed by the Board of Trade, of any such solid or liquid substance on an area shown on a chart referred to in the consent, and in accordance with the conditions laid down in that consent. Any person acting in contravention of this bye-law shall on summary conviction be liable for each offence to a penalty not exceeding £20."

16581. You are reading now from?—From one of our own bye-laws.

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16582-3. From one of your own bye-laws?—And I may say, as regards the Lords Commissioners of the Admiralty that they deposit within this given area at a very largely increased expense to the nation. The London County Council deposit in the Barrow Deeps by arrangement, it being shown that practically that is not detrimental to the fisheries, there being no fisheries in that particular part, but I believe there is evidence now to show that although this enormous amount of refuse has been deposited there, there has been no silting up of any kind, and, therefore, it may be assumed that this refuse disperses by degrees, and, of course, it might be washed all round the estuary.

16584. What in the first place is the nature of that refuse; the refuse which is dumped down in the Barrow Deeps by the London County Council?—That is solid sewage refuse.

16585. Sludge?—Sludge, yes, which they cannot dispose of and discharge into the river at their outfalls.

16586. A large quantity consists of chemical materials which have been added to the sewage?—I believe it is chemically treated before it is disposed of.

16587. There is no evidence that that has been injurious to the fish or the other inhabitants of the sea at the Barrow Deeps themselves?—No, not at the Barrow Deeps themselves.

16588. You succeeded in preventing the deposit of bedsteads and other things?—We have.

16589. So that the mere mechanical interests in the fishery, the nets and so on, are not at all injured by this?—No, I may say that we have reason to believe that the London County Council sludge boats do not always go to the Barrow Deeps. It is absolutely denied by the London County Council that such a thing happens, and they always assure us that if they found it out the captain of the boat would be instantly dismissed. That has been before us, and that has been stated to other bodies, but we still have reason to believe that they do not always go to the right place.

16590. And it is one of the difficulties that there is no adequate means of ascertaining?—We have not caught them; but now a system, I believe, exists that these boats have to report themselves at one of the lightships, and so there is a sort of check.

16591. (*Colonel Harding.*) Is the suggestion that they go further than the Barrow Deeps?—No; they do not go so far—that is the suggestion.

16592. (*Sir Michael Foster.*) But if they do not go so far they would still be within your area?—Oh, yes.

16593. But do I understand, Mr. Gibson, that at present there is really no harm being done by this deposit of material by the London County Council at the Barrow Deeps?—Not at the Barrow Deeps, because that is not a fishing ground, nor is it a navigation ground.

16594. Well, but you seem to think that the material dumped down there is carried away by currents and so on from the Barrow Deeps to other places, where it does interfere with the fishes, using fishes in the very general sense. I gather that is what you said just now?—I would rather put it in this way, that looking to the immense amount of sewage that directly or indirectly finds its way into the Thames, and looking at the fact that the London County Council are daily putting into the river this immense amount of sludge.

16595. A large portion of which is not sewage but chemicals?—Chemicals; anyhow, that together is to a certain extent at least polluting the Thames.

16596. Then your view that the material, keeping ourselves at present entirely to this sludge dumped down at the Barrow Deeps, your view that that is injurious to the fishing industries within your control, is a theoretical opinion; what distinct evidence have you got of it?—No, I do not think it is theoretical.

16597. What evidence have you that the material dumped down at the Barrow Deeps has been carried away to regions where there are fishes of one kind or another, and has interfered with those fishes; what is the evidence?—Well, if I may be allowed to put it this way, some time ago a number of carcases of animals were condemned, partly through the Board of Agriculture. I do not know whether it was through ignorance or not; numbers of these carcases were thrown overboard—the majority of those carcases were washed up on the Essex coast beyond the estuary, all up Clacton way, and the county of Essex were put to hundreds of pounds of expense burying—getting rid of those carcases. Those were thrown over, as far as I can make out, not far from the Barrow Deeps, and they all washed to the Essex coast. I think, following that principle out, refuse would find its way to the fishes.

16598. That might be taken as evidence of the action of the currents; but what I was asking you was, what evidence have you that the refuse itself, if so washed, is injurious to the fishes, using the word fishes in the very general sense of the term?—You have the fact that certain fish at Leigh, at Southend, and at other places are tainted apparently; they must be tainted, being in the water, by what is in the water.

16599. When you say tainted, do you mean that the flesh of the fish is tainted, or that they contain some polluted water in their insides?—No; I say that they are affected with some bacillus; but if they are the taint may bring on disease. I do not think I can carry it further than that. It is rather scientific.

16600. Your position is this: I mean that at Leigh, and so on, certain shell fish there have been proved to be contaminated by sewage, and to carry pathogenic organisms, and you presume, therefore, that the same is applying all the way along the coast, where the material is washed from Barrow Deeps?—Well, I have just thought of an absolute case. Messrs. Baxter, the oyster merchants, had "layings" in the mouth of the Thames near Leigh, off Hadleigh; they became so polluted that they had to take them away altogether within the last few years.

16601. Quite so, but I suppose that the material which got washed from the Barrow Deeps is relatively small to the rest of the sewage which is coming down the Thames from the works?—I do not know, sir; you have these enormous great hoppers day by day doing it.

16602. Anyhow, the question of the Barrow Deeps is simply a side question to the general question of sewage in the estuary?—I think if it were a question of the Barrow Deeps alone the Fisheries Committee would not have serious grounds for complaint as far as I know.

16603. Then, under the Act you are prohibited from taking any action in these matters?—Practically, yes.

16604. Such action as you do take would be governed, I understand, not because this sewage is injurious to the fishes themselves—the shell-fishes themselves—but it is injurious to the fishing interest, because it renders, or it is liable to render, the fish hurtful when taken, and therefore when it occurs the fishing industry is injured?—I would go further than that, because directly you get this sludge washing over the fishing grounds the fish leave, unless you have a nice clear, sandy bottom—I mean, the fish will not be there.

16605. You have evidence of that?—Yes.

16606. I mean, that the actual fish themselves had been driven away?—They would be driven away.

16607. But you have evidence that they have been driven away?—Well, that is difficult to say. I mean, there are so many things that will drive fish away. A bad season will drive them away, and they will not come up at all, simply because the wind is wrong, or something of that kind.

16608. I want to know exactly your position. Does the sewage interfere with the general prosperity of the fishes themselves, or does it interfere with the prosperity of the fishing industry, because it renders the fishes objects of suspicion?—Both, I should say.

16609. Well, then, what evidence have you of the former—is it not a fact?—The practical fishermen tell me—I cannot go further than that—that if there is this bad stuff put upon a fishing ground the fish will not come there.

16610. (*Sir William Ramsay.*) Is there evidence that the grounds are really dirty?—Yes.

16611. They are dirty?—They are dirty.

16612. (*Sir Michael Foster.*) Can you refer us to any evidence of that kind?—I think you would have to call the fishermen for that.

16613. (*Mr. Power.*) Do they not complain also that they get their nets full of the garbage, and that it takes them many hours to clear their nets; that thus they are driven away from the fishing grounds?—I do not think it goes so far as that, because there is an immense area for this sludge to work over.

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16614. But the discharged refuse drives along with the tide; have you heard no complaint of that sort?—No.

16615. (*Sir Michael Foster.*) Is it not a fact that the material of the sewage, at all events, that it has been acted upon to a certain extent with sea water and mixed with a certain quantity of sea water, attracts a very large number of minute organisms, minute crustacea, and so on, which actually live upon the sewage, and that these crustacea attract fish and form food for the fish, so that between the two it is the sewage which contributes to the advantage of the fish?—That may be so, but when those fish are caught, clearly they are not fit for human food.

16616. But what evidence have you as to that?—They are tainted.

16617. By fish, I mean all vertebrate fish?—Yes.

16618. Do you think we have any evidence of disease being carried through fish in that way?—I do not think that the flesh of fish would be affected.

16619. From your knowledge of the fishes, is there any truth in that statement which one has seen made here and there that sewage to a certain extent may contribute to the vertebrate fish population?—Not, I think, in a great mass of water; no, not like the Thames estuary.

16620. But when it is diluted it produces its effect with less danger?—Oh, but it is the stationary fish that are affected, that are there from tide to tide. Sewage is constantly passing over them and being deposited and lifted up again, and being deposited again. I do not know if you know Southend. If you look at the state of the mud there you will get a pretty good idea what the estuary is; you will get over your ankles in black mud.

16621. Then is your position that the discharge of ordinary sewage—we will pass away from the dumping down—do you think that these sewage discharges are interfering with the fishing industry, and that you have no adequate power for applying a remedy?—Yes.

16622. You say that up the rivers which were within your control, the Crouch and the Blackwater, you have control over the tidal portions only?—That is so.

16623. Is there any large discharge of sewage in the portion of these rivers beyond the tidal portion which would be carried down, and so be injurious?—No, I should think not; there are small villages.

16624. As you say, Maldon is within the tidal area?—Yes, I think I may say that really looking at the matter in this way it is a question between sanitary interests and fishery interests. Where the fishing interests are very ancient, and probably earlier than the sanitary interests, then we think the fishing interests should be very carefully safeguarded. When, on the other hand, a concession has been granted, say, for an oyster company to put oysters in a certain spot recently, and at that time there was existing the big sewer further up, I do not think that we can say very much, but we do venture to suggest that the existing outfalls should be watched, and that as regards new outfalls, none should be sanctioned near shell-fish beds, and that there should be some method of checking the conditions which have from time to time been imposed as regards the discharge of sewage at certain states of the tide. I do not think we can ask for more than that. I mean that we cannot ask that the whole of the sewage system of the Thames should be taken away; I do not see how we can, but at the same time a great deal might be done to ameliorate the conditions if the sanitary authorities, from the London County Council downwards, chose to do it.

16625. May I ask you, within your area do you know the number of beds and layings which are older than the existing sewers?—I should not like to say. I am afraid you might take me back to Roman times. I think the Colchester layings are as old as the Roman times.

16626. Roughly, have you any idea—is the majority of the layings layings which were there before?—I say the oysters were there before the sewers in many cases.

16627. (*Sir William Ramsay.*) Perhaps the easy way would be to ask if you know of any recent oyster layings which have been granted in your time?—There have been grants within the last 30 or 40 years—two or three. But just to give an instance of a case: Herne Bay; they have got an outfall there going out to sea pretty much, I think, in front of the place, and in close proximity to shell-fish beds. The state of the effluent is not satisfactory. A little time ago they asked for permission to extend that effluent a little further out to sea. They got that permission. That again brings that outfall nearer to valuable fisheries. Well, I would venture to submit that a thing of that sort should not be done in these days unless after the most careful consideration and proof that the sewage cannot be taken elsewhere, beause it is simply perpetuating what is already a serious nuisance, not only from fish, but from general sanitary grounds.

16628. (*Sir Michael Foster.*) You said a little while ago that where there was an oyster bed no new sewage outfall should be permitted. Just now you said it is not possible to do otherwise?—Quite so.

16629. I mean, supposing there is a town which can only discharge—can only get rid of its sewage by discharging into the sea at a certain place—if that is the only possible way, you would not abolish the whole of their sewage for the sake of the oyster bed which had been placed there?—Well, I do not know how far science has gone, but it is a question whether it is not possible to dispose of all sewage quite apart from using rivers. There must be overflow storm water, and that sort of thing, but a great deal of the dangerous matter might be got rid of.

16630. The dangerous matter, yes; well, one or two of the witnesses before us have made a distinction between what they call "crude sewage" and "treated sewage," and they seem to think that it was only the crude sewage that was at all hurtful to the fisheries; is that your view?—It would depend upon the place and the quantity.

16631. There are two bad influences of the sewage; one is the more or less mechanical one, is it not—the large quantities of the material?—Yes.

16632. And the other is of its being the channel for an organism which may give rise to disease?—Perhaps I may illustrate what I mean in this way: Just above Leigh, where these cockles are said to be infected, is Benfleet. Benfleet within the last few years got the consent of the Local Government Board to put its sewage effluent into that creek. I have no doubt whatever that the sewage coming from Benfleet outfall has very largely contributed to the pollution of the Leigh cockles. That is because it is a very narrow place there; there is not sufficient breadth of water to minimise the harmfulness of the sewage, but that has been done within the last few years. I say in a case of that kind every effort should be made to keep that away from the fisheries just below.

16633. No, my point was rather this, in this way: it is possible to treat the sewage in such a way that the effluent should be perfectly clear and limpid without smell; do you see any difficulty in permitting such an effluent to be discharged in the neighbourhood of your beds?—If it were possible to get and keep up such an effluent there would not be the least objection, but at present I do not think there is any authority who could put a perfectly pure effluent into the river, not even the London County Council.

16634. I am speaking now simply of a chemically pure effluent; supposing it were so, would you be content with that?—If it were possible to turn perfectly pure water into the sea.

16635. I do not say pure water?—Chemically treated.

16636. I mean, the sewage which has been treated, say, with chemicals, or otherwise; it appears quite pure; there is no smell; it does not decompose and is not in itself a nuisance, but may contain pathogenic organisms; may contain, for instance, the germ of typhoid fever; the sewage may be rendered quite clear, and yet contain the organisms. You would demand, I suppose, that the treatment should not only be such as to render it no longer a nuisance to the nose or eye, but also, for the sake of the fishing industry, free from the germs of disease?—Well, I should not call it pure unless it were free from the germs of disease.

16637. And you would not be satisfied with the treatment?—No.

16638. That is the point I wanted to bring out; so you do not agree with those witnesses before us who would be content if the purification were such as to simply render the sewage no longer a nuisance?—No; certainly not.

16639. You demand that the pathogenic organisms, the possibility of disease being introduced through the sewage into your fisheries, should be prevented?—Exactly.

16640. Have you any idea how the results that you wish for could be obtained, by what organsiation or by what measures? You yourself, you see, have no power. Your powers are limited by that section of the Act; you can only appeal to the Sanitary Committees of the country?—Well, the cheapest way, if I might say so, to do the matter thoroughly would be to compensate those who have private rights in the Thames; get rid of them altogether, and then it would not matter if the Thames were more or less a sewer from our point of view.

16641. The first point you will have to decide is whether injury is being done?—Quite so.

16642. Are you to be the sole authority for that?—The Fishmongers' Company have inspectors, the Corporation of London have their own experts and others; they have examined these beds, and they say they are polluted.

16643. Taking it over the country generally, you have no bacteriologist, and apparently you have no means of arriving at a scientific opinion; therefore I suppose you would not be the proper authority. There would have to be some other authority to decide whether it was a case of injury or not?—I think there would have to be an independent authority to decide such a question as that. Undoubtedly it would not do for us to decide it; it would not be fair.

16644. Have you formed any idea what that independent authority should be?—I cannot say; I have never gone so far.

16645. You come into contact with the Thames Conservancy, I think?—Yes.

16646. That has never given rise to any difficulties?—No; we have had little disputes now and again, but nothing serious.

16647. Nothing serious; you have worked together very well?—Oh, yes.

16648. And you think what applies there might apply to other rivers in the country?—But they have not sufficient powers or efficient powers; they cannot do what ought to be done.

16649. If they had, perhaps you might be coming into conflict?—Well, I mean, for instance, they are perfectly aware of the state of the outfalls of the London County Council at Crossness and Barking, and so are we, but what can be done? All we can do is under an old Act to make complaint to the Local Government Board or one of the Departments.

16650. And you think there is urgent need for steps being taken to remedy that?—I think so, and I think the fishing interests of the Thames are entitled to a certain amount of consideration. It is not necessary that their interests should be paramount, but I think they should receive some consideration, and I think they might be helped by stopping any new outfalls into the estuary, looking at what the estuary is from a fishing and commercial point of view.

16651. That were not adequately and completely purified?—Well, the pollution is growing bigger every day. For instance, London is constantly taking into its sewers——

16652. The addition of a perfectly pure effluent would diminish the pollution rather than increase it?—But what I rather meant was this: only a few years ago we knew nothing of any of these scares, or at any rate they were not made public. Now, they are occurring constantly, and the chief reason is because a larger amount of sewage has to be treated in a given area. The London County Council are constantly taking into their sewers additional authorities. Only a short time ago they took into their sewers the county borough of West Ham, with a population of 250,000; now they are going to take over East Ham, with a population of 100,000; and so they go on. That all means more sewage poured into the river and finding its way over the fish beds.

16653. I suppose I am right in saying it is the scare which does the great damage to the industry, is it not? I mean that the industries would be willing to submit to very considerable restriction if they were assured that thereby those repeatedly recurring scares would be avoided in the future?—Yes; I am afraid something more than a scare as regards our district; it is the fact, it is not the scare; I mean there is the pollution; we cannot defend it in certain parts of the district.

16654. (*Sir William Ramsay.*) Is there any actual deposit over the shores on the coasts of Essex and Kent? I think you spoke of a black, slimy deposit; is it an obvious thing?—I cannot say whether it is harmful in itself.

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16655. No, is it an obvious thing—can you see it?—Oh, yes.

16656. Is it smellable?—Yes.

16657. Does not that influence the population going to such seaside resorts?—No.

16658. They go all the same?—They go all the same; with eighteenpenny fares they would go anywhere, no matter what the state of the place was.

16659. (*Major-General Carey.*) In the case of the Herne Bay outfall extension, which you say has made matters rather worse than they were before the scheme, the District Council, I presume, went to the Board of Trade for permission to extend?—I believe it did.

16660. Was that referred to the Fisheries Committee?—Yes.

16661. As to the possible injury to the fisheries?—It was.

16662. Did they make any protest?—There was a local inquiry, and in that case the Fisheries Committee was represented, I believe.

16663. At the inquiry by the Local Government Board?—I believe so; the Local Government Board inquiry. One of our fishery officers lives at Herne Bay, and he took it up.

16664. And do you say that the danger of extending the outfall was pointed out by the Fishery Committee at the inquiry?—Yes.

16665. And that nevertheless it was carried out?—It was carried out.

16666. In spite of your protest?—Whether in a modified form I cannot say, but it was carried out; the sewer was extended further into the sea, no doubt to preserve the shore and keep the people in a healthy state there.

16667. But, as I understand, it brings it nearer to certain shell fish beds than it did before?—Quite so, perpetuating the nuisance from the fishing point of view.

16668. Did the Board of Trade take any action in the matter; were they represented at the inquiry?—I do not think they were; I was not there myself. The Committee employed a separate solicitor.

16669. And as regards the discharge of sewage at certain times on the ebb tide, would there be any difficulty in the Fishery Board ascertaining whether it was so discharged if they made any inspection at all of the coast?—I do not think we have the means for doing that at present, but if we had the means there is no penalty. I suggest there should be inspection, and a penalty recoverable in a summary way, so that these men are kept up to their duty. Their object is only their master's interests, and if they can get rid of the sewage, etc., they care nothing for the Fisheries Committee; therefore it is a temptation to them to manage the thing anyhow so long as they get rid of the stuff.

16670. But the Fisheries Committee could ascertain without much difficulty that it was being carried out according to the original intention?—They could if they employed an expert to do it, but whether the cost of employing that expert would be allowed by the Local Government Board auditor is another thing.

16671. (*Mr. Power.*) Have you authority to enter upon their works and watch their proceedings?—No, not if they are working under statutory powers; they would be working under the Public Health Act.

16672. (*Sir Michael Foster.*) Clause 13, Section "C": you say with regard to the local authority discharging sewage in pursuance of any power given them under this Act?—Yes.

16673. Is it always the case that a power is given where a local authority discharges a sewer; can you always quote what power they are doing that under?—I do not know of a single authority discharging sewage in our district that is not doing it under statutory powers.

16674. Under a definite statutory power?—As an authority, because where two drains join together it is a sewer under the local authority.

16675. General, Local Act of Parliament or a Provisional Order?—Yes.

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16676. In all these cases, therefore, there is either the general Act or a local Act, or a Provisional Order?—Yes.

16677. And you have satisfied yourself as a lawyer that that does exist in each case, because if it does not exist then they are removed from this bye-law, and you could proceed against them, could you not?—No doubt they could, but if we found one sole authority turning some stuff in, comparing with the general amount of sewage going into the Thames, proceedings against that one authority would be of no value, I am afraid.

16678. But this is a local authority, you say?—Yes; I am not aware of any local authority going outside their statutory powers in discharging into the Thames. The London County Council have full power; all the Urban and Rural District Councils have powers under the Public Health Act. Then there are Provisional Orders, I believe, in certain cases, but I am not aware of one doing it without some statutory power.

16679. You have satisfied yourself, have you?—So far as I am aware, and I know the coast pretty well.

16680. I suppose the Public Health Act of 1875?—Yes.

16681. Under which section?—That I would not say offhand.

16682. (*Chairman.*) You do not pretend to be a master of the law, I suppose?

16683. (*Sir Michael Foster.*) No; but, Lord Iddesleigh, the limitation to the action of the Fishery Committee depends upon there being a very definite power, and if the Fishery Committee acknowledge that there is that power they cannot proceed, and I suppose it is their duty to see in each case that there is that power?—Yes.

16684. Otherwise it would be their duty to proceed?—Yes; I submit that there is that power generally.

16685. (*Sir William Ramsay.*) You also say that it is not worth while proceeding in a very few cases?—Not a bit. Supposing three or four cottages draining into a creek. One would not interfere; it would be a waste of money.

16686. (*Colonel Harding.*) But do you think the Public Health Act gives them the statutory power to do this turning out of the sewage along the coast?—Well, sir, I should not like to fight them upon the point without further advice.

16687. There seems to be a clause, sir, bearing upon it—Clause 17.

16688. (*Sir Michael Foster.*) The absence of a prohibition is a different thing from a specific power, is it not?—Yes.

16689. But have you not been content with the absence of the prohibition, and not satisfied yourself that there is a specific power?—Well, to put it another way, I should not think of advising my committee to take proceedings against any local authority for draining into an estuary—unless there was a chance of success. To begin with, I should have everyone against me.

16690. (*Colonel Harding.*) Does the question of prescription come in, that these people have done this for so long; does that prevent you?—No, I think not.

16691. That would not?—No.

16692. There is no intention on the part of your authority to take a test case, is there?—I do not think so, no. I should not advise them to take a case, for I have always considered that under the Public Health Act it is the duty of the sanitary authority to drain the district, and if they can get all their powers so as to get their drain into an estuary after treating their sewage to the satisfaction of the Local Government Board, there they are under statutory powers.

16693. But, as a matter of fact, do they treat their sewage generally, or is it turned untreated into the estuary? In a great majority of cases it is not treated at all, is it, on the coast?—To a certain extent it is treated, I think. Colchester, for instance, treats their sewage; London, of course.

16694. What do they do; do they settle the solids?—Yes. I think Malden treats its sewage to a certain extent.

16695. While sewage is untreated it would certainly seem Section 17 of the Public Health Act might be quoted to prevent them doing this. Of course, if it is treated, and it is treated, as you say, to the satisfaction of the Local Government Board, the case is different. Where there is no treatment at all I do not think the Public Health Act by itself seems to warrant their doing what they are doing?—But I think, sir, to put it another way, it is clear that the London County Council have power to put their effluent into the Thames.

16696. There you evidently cannot interfere with them—the London County Council?—It is at the bottom of the whole pollution in our district, in our opinion.

16697. I understand you to say that the pollution by the London County Council is much more serious than the multitude of small parishes all along the coast?—Oh, yes; it is a different thing altogether.

16698. You really think that reaching the coast greatly diluted by sea-water is more dangerous than a drain turning out crude sewage quite close to an oyster bed?—Well, it would all depend what that drain was. If it was the drain of a single cottage I do not think it would matter in the least; the drain of that cottage turned over an oyster bed.

16699. (*Sir Michael Foster.*) If there were typhoid fever in that cottage?—I do not think it would do any harm; it would be so very small compared with the large amount of water.

16700. One case of typhoid fever which might be in a cottage only would very easily pollute a very large oyster bed?—I should have said the flow of sewage from a single cottage is very small indeed.

16701. Probably the relative proportion of the typhoid germs in it is greater?—But a great deal never gets to the estuary at all. There are leaky pipes.

16702. Supposing a case where the drain, as Colonel Harding said, went right on to the mussel bed or the oyster bed, and so on, you said because it was only a cottage it did not matter, but that cottage might have a case of typhoid fever, and that special oyster bed might be an oyster bed supplying London, and that one cottage might poison all the aristocracy of the metropolis?—I do not think the drain would go right over the bed; generally the oyster beds are some way away from the drain.

16703. But near enough to contaminate the bed; that was Colonel Harding's point. There was one other suggestion perhaps I might make, whether the Local Government Board has power themselves to inspect these outfalls from time to time and see what is being done?—I do not know whether it has or not through an officer, but that would be helpful to us if a responsible Government authority took the matter up. I do not think it can be put upon the Fisheries Committee to inspect these outfalls; I am afraid not; I see difficulties in the way.

Mr. J. Cole.

Mr. John Cole, Poole, Dorset, called; and Examined.

16704. (*Chairman.*) You own some ponds at Poole?—Yes, my Lord.

16705. Can you tell us where your oysters come from?—Well, I import them from different places sometimes, from where I can get them. I have imported them from America and from the Sea Salters' Whitstable Co., and from the Mumbles; well, nearly from anywhere where there are the best facilities for getting them.

16706. You deal in almost every class of oyster?—Yes.

16707. And what is mainly the area in which they are distributed; what do you do with them?—Sell them out to the shops. I receive orders in the morning by post or telephone or telegraph, and they are sent direct away to them.

16708. But do you put them into your own pond?—Oh, yes, in our own waters. Never get anything out of the water; never unless ordered.

16709. Then you have sold them straight from your own ponds?—Yes, direct.

16710. How do they generally reach you, by boat or by train, or both?—Oh, they come by train—the whole.

16711. The whole of them come by train?—Yes.

16712. And how are they generally packed?—In casks or bags, according to the distance they have to come. If they come from America they come in dry casks; naturally they would keep and be preserved far better in dry casks than they would in water. It would be impossible to bring them in water, because the water would get bad and contaminate the fish, but coming in dry barrels, they contain sufficient water to last them over. Then they are relaid again in our waters and then sold.

16713. And if they come only a short distance in England they are packed in bags, you say?—Sometimes, and sometimes in barrels and sometimes in cases.

16714. Are there any native oysters now dredged up in Poole Harbour?—Oh, yes, what fishermen call the real Poole native.

16715. Do you own your ponds, or do you hire them? —Well, I have taken the ponds I am using at the present time over by agreement.

16716. Are there any drains that discharge near you? —Well, I have always considered the ponds that I am using perfectly free of sewage. There is a pipe—I think a 4-inch pipe—running out from the naval battery there, but that extends a long distance outside my beds, and, in my opinion, it is an impossibility for any sewage to come from that pipe into my beds.

16717. (*Sir Michael Foster.*) But are there not six drains there?—I think above that again, to the westward of that, I think there are four drains. I do not think you would find more than four; that would be from three to four inch pipes, and I think I could honestly say that is not sewage.

16718. (*Chairman.*) How far from your ponds would the nearest pipe discharge?—Well, I should think one from mine would be 100 yards or more.

16719. Have you ever had either the oysters or the water from your pond examined bacteriologically?—I think they have done so, sir. I think they have taken samples of the water.

16720. Do you know who examined it?—Well, I should not like to say to be certain, but I think the Medical Officer of Health of Poole.

16721. And do you know what the result was?—No, I do not.

16722. How long have your ponds been in existence? —Well, I should think they have been there—I should not like to say; in fact, I cannot say to a twelvemonth, but I should say 14 or 15 or 16 years.

16723. And as to these drains which are nearest you, have they been there all that time?—Yes, and before the beds were put there.

16724. The drains were there before the beds?—Yes, and I think I can say to you, gentlemen, honestly and conscientiously as a man, that I have never had a case of any typhoid or illness of anyone; never heard of a case of illness from any of my customers from eating my oysters.

16725. (*Sir William Ramsay.*) How long do the oysters that you bring from the country and abroad lie in your ponds?—Perhaps they may be in there while they are under the fattening process; perhaps a month. Then they are packed off to the market and restocked again.

16726. (*Major-General Carey.*) Why did you put the beds down so close to the drain?—Well, it is simply the place that was granted to the company by the Board of Trade. You see, we cannot pick our space.

16727. (*Sir Michael Foster.*) These are old beds, are they not; they are beds which have been used for a long time?—Yes; what I call store ponds.

16728. Store ponds?—You could not do without them.

16729. They were used by others before you?—Yes.

16730. They are created by the owners?—Yes.

16731. The drains have been brought there since the ponds were laid down?—No, I believe the drains were there formerly.

16732. I see on the map here there are six drains?—I should not like to say that; all I know of at the present moment are five; I do not think you would find more.

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16733. You say there it is not sewage?—Well, I believe the four drains at the westward of the battery drain is only like washwater and the drip down from the sinks, only I should not like to say all.

16734. No privy stuff or urine gets into it?—Well, I should not like to say, but I believe not. I would rather say not than the other way; still, I may be wrong. At the same time, I should not like to make anything of a wrong statement in any way. Take the extent of Poole Harbour—96 miles in circumference; hundreds of millions of tons of water flowing in six tides in 24 hours; what would come from these pipes, in my opinion, would not be worth mentioning; it would not be noticeable to the quantity of water.

16735. (*Sir William Ramsay.*) How do you count oysters; by the number?—Yes.

16736. About how many would be kept in your pond?—Well, sometimes 20,000 or 30,000 to 100,000, the stock.

16737. It would hold up to 100,000?—Yes, I should think I could stock 100,000. Then, you see, look at the state of tides; the amount of water flowing in and out six times in 24 hours; it is a six hours' tide; the tide 2½. Then there is what is called the second flood —rises for an hour, then the other tide falls away 2½, then the fresh water supply again for six hours, and there is a continuation of that pure water flowing in and out of that place every 24 hours. Then I should think that is the extent of the whole sewage in Poole Harbour, is these four drains. I am under the impression, in fact, I can say they are going to be removed. I can say for certain. I have seen the tenders are accepted for their removal.

16738. (*Major-General Carey.*) The drains?—I think when they are removed Poole Harbour in my opinion will be perfectly pure from all sewage.

16739. (*Colonel Harding.*) What you tell us seems, no doubt, very likely, but if the small amount of sewage is really mixed with that vast amount of water the danger will be comparatively small?—Yes.

16740. But here you have drains discharging close to these layings, and they discharge in shallow water, and there is not that mixing with the vast volume which you spoke of; is it not possible to do one of two things, either for these drains to be removed—I think you say they are likely to be removed?—Yes.

16741. Or, on the other hand, for you to find safer positions for these layings?—I do not think you could find safer positions.

16742. Than at the mouth of sewers?—Well, I do not know at the mouth of sewers. I should not like to make these statements. The beds I am using have no drains whatever, as I have said, within 100 yards.

16743. Well, there are on the map five or six drains? —That has nothing to do with my beds. There are no drains within 100 yards of my beds.

16744. Are your beds near the Naval Reserve quarters?—Mine are to the eastward.

16745. There are beds there?—There are beds to the westward.

16746. Between the two sets of beds is there not a 4-inch pipe?—Yes.

16747. Would it not be possible for you to find another site for those beds, where you would not be near drain pipes?—It might be possible by the Board of Trade granting me a site, but look at the expense of removing them and rebuilding them elsewhere.

16748. Are we to understand that the Board of Trade have sanctioned the position which you have selected? —I do not know about that; all I say is that the Board of Trade were the ones that gave the sanction for them in the first place.

16749. Then you did receive the sanction of the Board of Trade?—I never received the sanction.

16750. But your predecessor?—My predecessor received the sanction, I suppose that; the beds are there, and they are there by the sanction of the Board of Trade.

16751. And the difficulty of going a little further off where there would be no drain pipes would be the difficulty of cost and the difficulty of getting the sanction of the Board of Trade?—Yes, it would at the present time, certainly. In the first place, before they were built there, certainly they could be built somewhere else, if

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the site could be granted, but now there would be an enormous expense to remove it all, and rebuild it somewhere else.

16752. (*Sir Michael Foster.*) About what expense would it be?—Well, I should think myself it would cost £30 a pond, a store pond, which ever you like to put it.

16753. You have got four ponds, have you not?—Three at the present time.

16754. (*Colonel Harding.*) As a fact, are there any other sites near there which would be free from the neighbourhood of drains?—Well, it would be too far away.

16755. Well, how far?—To get to anywhere really a free site, you would have to go two miles further away; that means two miles further carriage away from your destination, getting your stuff away.

16756. Apart from the question of extra carriage and so on safety could be attained?—Oh, yes, I maintained that as soon as these pipes are removed it is perfectly safe, and I do not think you could get a better site in the place than that. I do not think you could go anywhere and pick a finer site when these drains are removed than you would find there, gentlemen. I think I may stand honestly and say that you would not find a finer site in Poole Harbour when these drains are removed than they are at the present time.

Mr. A. L. Scott.

Mr. Adam L. Scott, Poole, called in; and Examined.

16757. (*Chairman.*) Will you tell us whether you deal in American, French, and Portuguese oysters, or one kind?—In all kinds you have mentioned, except the Portuguese; I do not deal in those now.

16758. And you put them in your ponds?—Yes, my Lord.

16759. How do they reach you, by train or by boat?—By both; by boat to Southampton, and then by rail.

16760. And are they packed in barrels or in boxes?—The Americans are packed in barrels and the natives in cases—the French oysters.

16761. Do you hire your ponds or own them?—Well, I should say own them. They were sanctioned by the Board of Trade, and assigned to Mr. Henderson on his application.

16762. They are your own property; they belong to you; you do not rent them?—No, my Lord.

16763. Do any drains discharge near them; how near would the nearest drain be.

16764. (*Sir Michael Foster.*) Whereabouts are your ponds?—On the foreshore at Hamworthy, in the Hamworthy boundary; not the Poole boundary, it is Hamworthy.

16765. (*Chairman.*) How many yards would you say the discharge of the nearest drain was from your pond?—I should say about 50 yards, I should think; I am only guessing, because I have never actually measured it; I did not think it necessary.

16766. Have the oysters or the water from your pond ever been examined bacteriologically?—Well, I do not know that; yes, I should say it was bacteriologically. Dr. Bulstrode when he visited took some samples of the oysters and water, which was, I suppose, for that purpose. I had tried to get it done myself, but the cost was far too much, of which I have proof. I also offered my oysters for analysis to both Poole and Bournemouth Sanitary Authorities, which they did not accept.

16767. You do not know what the result of that examination was?—He replied in a letter to Mr. Henderson, saying that they were only taken to see if there were any micro-organisms in the economy of the oyster. I could not quite understand the matter myself; but not really for analysis of any other germs, typhoid germs.

16768. How long have your ponds been in existence?—Since 1891, the first one.

16769. And have the drains you speak of been discharging there ever since. Were the drains there before the beds or the beds before the drains?—The drains were there first.

16770. (*Sir Michael Foster.*) What amount of sewage comes down through these drains—a large quantity. How many houses do the drains drain?—The small drains on the foreshore opposite to the bed; I think it is five small drains, but there is no sewage from them.

16771. What flows through them then?—Washing water.

16772. (*Major-General Carey.*) Slop water?—Rain from the houses and draining from the yard.

16773. (*Sir Michael Foster.*) There is nothing from the privy?—Nothing whatever; in fact, there was when Dr. Bulstrode visited me, but since then I have prevailed upon the sanitary inspector at Poole to get this altered, and they have put in proper earth closets, and that is done away with; anything of that kind.

16774. And the urine, do those contain any urine?—No, sir, oh, no, that is not in it.

16775. What is done with that then in those cottages; it goes into the earth closet?—Yes, sir.

16776. Or elsewhere?—Yes, so the sanitary inspector told me; there was no sewage going through those ones only from the drains at the Royal Naval Reserve Battery. There is sewage from that; a little sewage.

16777. (*Sir William Ramsay.*) Is that a long way off?—About 100 yards or more.

16778. Are your ponds close by the ponds of the last witness?—Yes, fairly close.

16779. (*Sir Michael Foster.*) The same side as the Royal Naval Reserve Battery?—No, not the same side as the Royal Naval Reserve Battery, on the opposite side above.

16780. The opposite side?—Yes, to the westwards.

16781. (*Sir William Ramsay.*) How many oysters do your ponds hold, roughly speaking; how many have you as a rule down?—Well, comfortably 60,000 to 80,000 oysters.

16782. They usually contain that?—No, we never have them filled like that. The only time we have any quantity would be from the spring months to the autumn during the summer, when we cannot get any oysters at all.

16783. And then they are pretty full?—Well, no, we do not keep a large stock now; we only keep a small stock; they are more sold out, and then a fresh stock in at short intervals.

16784. What do you call short intervals. How long would they lie as a rule?—I should think the longest would be about the summer term, from April to August, or September.

16785. But they always stay for a certain amount of time in your ponds—weeks; do you often sell out under a week?—In the deep sea oysters, that is the only ones we would sell out, and cannot get them probably within the time to have some to go on with. Every other oyster is there under a month before it is sold.

16786. (*Major-General Carey.*) Are the drains which discharge on to the foreshore quite close to the oyster beds going to remain?—No, sir, I see the Poole Town Council has accepted a tender for a new drain to divert that sewage both from those small drains and from the shore.

16787. (*Sir Michael Foster.*) But you said there was no sewage in those drains?—To take the water that comes; it is for their own benefit, the people living in those houses, because they are continually having to open their drains up every winter right through. They really do not come into the harbour; they are above the high water mark, these drains, but yet the wash of the seas in the very high spring tides with a gale of wind blocks them up, and the consequence is they have to do something for these people to have their drains on a better system, so that they are to connect with this one to go in between the quays on the opposite side of the land from our beds.

16788. (*Dr. Burn Russell.*)—Do you get any advantage from putting the oysters into this bed, except that of storage until you get a market?—The only advantage that I know is of growth; larger size.

16789. They fatten?—I will not say that they fatten; they keep the fatness that they have, but the only advantage that I can see is that they grow half as large

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again in the summer, the American oyster will and the Portuguese.

16790. (*Mr. Power.*) In the space of three months half as large again?—Little more than that; say, four or six months. The Portuguese oyster especially, they grow tremendously there. The great thing is, of course, that you are liable to break the new growth unless it is allowed to harden into shell.

16791. (*Dr. Burn Russell.*) Do you draw a distinction between that increase of size and the process that is called fattening. That is a different process?—Yes, sir; they would not fatten in those beds as they would out in the channel; not so quickly, not nearly so quickly.

6792. But what I mean is, is the growth in bulk of the creature, is not that what you would call fattening. Do you distinguish between the two?—Oh, no, sir, no; they are quite different, they only increase the size of the shell, that is all.

16793. The creature inside, surely does it not increase?—It would in time, but then they would not be there long enough for that, I do not think. It is all new growth you see, we never get them for that purpose —the oysters. We always get them large enough for sale there at once, but they do increase in size.

16794. That seems to show that the material that goes to increase the shell is got from a different locality from that which goes to increase the flesh of the animal?—Yes, I should think so.

16795. Do you think that is the case?—I think so, yes.

16796. What is the structure of these beds; what are they made of—concrete?—One is the natural bottom of the harbour there; it is very fine gravel grit, and the others have been all made with gravel put upon them. They are all hard bottom.

16797. But you will have a circumference. You will have some walls or something?—Oh, yes, board; boarded round to keep the banks from going in.

16798. Simply boards?—Yes, sir.

16799. Then, that cannot cost very much?—Well, it is not exactly the boards that cost the money, and yet they do cost; they have to have all oak, otherwise it is very soon gone. In a few years it eats away, and it is the labour really of driving in stumps, because they eat away in about two or three years; they eat away near the ground.

16800. You have to drive in piles?—Piles to keep the banks up.

16801. Then is the surface flush with the natural level of the shore?—The bottom of the bed you mean.

16802. No, I mean——?—The top of it.

16803. The top?—Oh, yes; yes, sir.

16804. So that anything coming from the landward side would flow into your beds?—It would; if the shore was all on the slope that way, it would do so, but it is not; the beds are really higher in one sense out there, because the fore shore has been taken away in between that and the fore shore.

16805. A sort of bank; something like a bank?—A small gutter way as it were between the beds and the foreshore proper.

16806. But I suppose every structure of that kind has to get the sanction of the Board of Trade before it is put down, if it is on the foreshore at all?—Yes, sir, I think so; everything of that kind.

16807. (*Colonel Harding.*) How long have you had those beds?—Since 1891.

16803. Were they sanctioned by the Board of Trade; were they then put down, or did you take them over?—The first one was sanctioned by the Board of Trade then.

16809. In 1891?—In 1891.

16810. And the drains on the foreshore were in existence then?—They were in existence then—yes.

16811. As a fact, those drains are only 10 to 20 yards from the bed?—The small drains.

16812. Yes; is that so?—Well, I have not measured it; I could not say. I should think it would be more than that.

16813. Can it be much more than that; by the map it looks to me to be about 10 or 20 yards?—Yes, sir.

16814. And, as Dr. Russell pointed out, the beds are exactly between the drain and the waters; is not that so?—The channel, you mean?

16815. Yes, the drains on the foreshore are near to you, and you are between the foreshore drains and the main water—the open water?—Yes, sir.

16816. So that unless there is some provision made for deviating the course of the flow from those drains, what does flow from the drains would pass over the beds?—Not necessarily, sir, because the tide would flow up and down in the opposite direction; and, therefore, anything would really go up and down with the tide.

16817. But, anyway, I am not far wrong in saying that the distance of the drains from the beds is not far; from 10 to 20 yards?—20 or 30 yards, say.

16818. 20 or 30 yards?—Yes, sir.

16819. And that that position was sanctioned by the Board of Trade?—Yes, sir.

16820. What is the difficulty in the way of your removing those beds to a position further off the coast where they would be further away from the drains; is the difficulty the cost of removal?—Partly that, and you cannot get another suitable place altogether for the oysters and for extra expense; there would be extra expense, and risk too. We thought of it, at least I did, that probably there was some place in the harbour that you could get free from pollution, but then it would be up, I think, the harbour, more in the fresh water; and, therefore, in the winter——

16821. Carriage would be greater?—Carriage would be greater; and frost, which s very dangerous.

16822. When there is a scare like the recent scare, does it not affect you seriously?—It does.

16823. Does it not affect your sale of oysters?—It does, sir.

16824. Would it not be worth your while to incur some expense in shifting to a safer position?—It would if we thought it would pay in the long run. I mean to say that there is this risk of frost in the further distance away in the higher part of the ground further up the channel.

16825. But have you come to see that a position which is within 20 or 30 yards from the mouth of sewers is not a good position for oyster beds?—Yes, sir, as far as the opinion goes—public opinion.

16826. And you think, in view of the serious loss incurred by the stoppage in the sale of oysters, that it would be worth your while to consider moving to a safer position?—Yes, sir, it would be.

16827. (*Sir William Ramsay.*) I suppose you think there is a risk on both sides? There is a risk in moving; it might not suit your oysters?—Yes, sir, there would be a risk in moving.

16828. (*Dr. Burn Russell.*) Do you pay any rent for the use of this place?—No, sir.

16829. Just the prime cost?—Just the cost to the Board of Trade.

16830. So that the profit of the locality is the business you bring to it?—To a great extent—yes.

16831. It is not any rent that you pay to the local authority?—No rate to the authority; they have tried to get us to pay rate, but we get the beds on that understanding really.

Mr. Alfred Brazier, Southwick, called; and Examined.

Mr. A. Brazier.

16832. (*Chairman.*) You own some ponds at Southwick, I think?—Yes, my Lord.

16833. Will you tell us where your oysters come from —whether you get them from abroad or only English oysters?—We get Portugal oysters, American oysters, Herne Bay oysters—too numerous to mention really the different kinds, Whitstable and Kent. Our chief oyster is Caen Bay.

16834. You have ponds, and you have layings, have you not?—Yes, sir.

16835. How near to either your ponds or your layings do the nearest drains come?—I may say we have no drains in Southwick; it is perfectly drained on the most modern system.

16836. You know that?—Yes, my Lord. There was no sewer at all until this last two years; now there is an intercepted sewer running into a tank sewer running under the main beach into the sea. There is no sewage whatever in any shape or form at Southwick arms. You must remember that there are two arms, Shoreham Harbour, the west arm, and the east arm. The west arm, I believe, the sewage from Shoreham town does go into the river. It is let off at half-ebb, but the tide runs about six or seven knots an hour, that it cannot touch our beds, as I say, because our tide would be running out at the same time; it spurs it out into the sea in a south-easterly direction, and goes away by the westerly tide. It seems to me almost impossible for any particle of sewage to enter our arm. And, more than that, my Lord, we have a continuous stream running over our oysters. In 1894 Professor Crookshank examined our oyster beds, both the water, mud, and the oyster itself, and we had a very good report back, and that was the time there was sewage running into the river, into our arm, but, as I said before, if there was sewage running into the river it seems almost impossible for it to stop there, because, as I have said before, we have a continual stream running by the flowing tide and the ebb tide.

16837. You mentioned just now that you had a most modern system of drainage at Southwick?—Yes, my Lord.

16838. Now when was that instituted—how long ago?—I think the outfall has been open close upon two years.

16839. Then it is quite recent?—Yes, my Lord.

16840. Then the drainage system has been changed?—Since Professor Crookshank examined the oysters, do you mean?

16841. Well, Dr. Crookshank, I think you said, made his examination of the water and your fish six years ago?—Yes; I think it is a little more than six years ago.

16842. And since that time the system of drainage has been altered?—Yes, my Lord.

16843. And improved?—Yes, my Lord.

16844. And what did Dr. Crookshank say of your water when he examined it?—He said there was no bacilli of typhoid in any shape or form.

16845. And therefore the drainage having since been improved, if you were all right six years ago, still more are you likely to be right now?—Well, we must be perfect now, I should think. Mind you, they throw it at me in Brighton. They say, "Well, Mr. Brazier, you belong to Southwick, but Shoreham is not drained, I believe." There is Shoreham; they may there, it may be possible, I am not certain there may not be some at Shoreham perhaps after it has gone out of the harbour, but it is almost impossible, I think; I do not know, but still there is just that doubt about it; there is no doubt Shoreham ought to be drained.

16846. How long have your own ponds been in existence?—Well, I should think 60 years; and I may say that 25 or 30 years ago Whitstable people, Kent people, and several more laid their oysters at our place; as many as 10 mercants laid their oysters in Shoreham Harbour; 30 years ago, in my father's time, we used to have about 3,000,000 oysters coming into Southwick and Shoreham. They were sold every week. We used to supply all the London markets with oysters, and the French markets, and all the towns round about. There was never any case of typhoid then, my Lord; 3,000,000 oysters every week were sold from there, until the Fecamp Fishery on the Normandy Coast failed, the Channel, the English Channel, then they began to drop off, the foreign oysters came into force.

16847. Have you had any bacteriological examination since Dr. Crookshank's in 1894?—Dr. Klein and the Fishmongers' Company sent down for a sample of my oysters. I think they took away 25 each from the beds and the ponds, 25 from the oyster ponds and 25 from the beds.

16848. How long ago was that?—That was in January, my Lord. In a few days they sent back a mere preliminary report, saying the oysters were polluted in both places. What they ought to have done was to have left me part of the oysters and taken part themselves, if they had taken the samples, and let me have my part analysed. Instead of that, they have never been gentlemen enough to send me a full report, only a preliminary report. That, I suppose, has gone on to Brighton. Well, I need not say it is no use them saying anything to Brighton; all the time you have got the facts, you may as well say nothing at all; there has never been a case brought home to us yet that I know of, not with our oysters. You would never get rid of a scare all the time you have a medical officer of health that is a faddist on shellfish and a Town Council to follow him and not to ask the question whether he has facts to put before them whether they be right or wrong condemning on supposition.

16849. (*Sir Michael Foster.*) When was the examination by Dr. Klein?—I think it was in January, sir.

16850. This January?—Yes.

16851. He had oysters both from your layings and from your beds?—Yes, sir, yes.

16852. Is the whole of the sewage of New Shoreham discharged into the harbour?—I believe it is, my Lord. It is let off at half ebb. The solids are retained by going through a sifting sort of a wire basket with coke in, and something of that kind, and then distributed on the ground.

16853. That comes down towards you for a long way, does it not?—Yes.

16854. To a point near the new lighthouse?—Not one; there are two arms. You must understand this Shoreham arm, there is such a long stretch of water, causes the tide to run at such an excessive speed. It runs right up to Henfield. It runs about six or seven knots an hour. Our tide runs at the rate of one knot an hour. It is almost impossible for it to come round to our arm, unless it does on the flood tide again; there may be a little come in.

16855. You think it is impossible for any portion of Shoreham sewage to come within any nearness of your layings or beds?—I think so, sir.

16856. (*Sir William Ramsay.*) How far off is Shoreham from you?—Shoreham from our oyster ponds is about two miles.

16857. (*Sir Michael Foster.*) And now with your new sewage works at Southwick itself your beds cannot be contaminated with your own sewage?—No, sir; there is no sewage runs into our sewers at all. I have been on the Port Sanitary, I am a member of the Port Sanitary, I am a member of the Council; you may be sure I would look to that.

16858. How do you account for the contamination which Dr. Klein found?—I say if there is any it may possibly come round on the flood tide, after it gets out of the piers from Shoreham; it must be Shoreham.

16859. This scare is doing you a great deal of harm, is it not?—Of course, it does; it has nearly ruined us.

16860. I suppose you would welcome any arrangement which could be made, even at some sacrifice to yourself, which would ensure that those scares are no longer required to frighten people?—I do not quite catch you, sir, on that point.

16861. It does you a great deal of harm the mere scare?—Yes, of course, it does; it has completely ruined us.

16862. Not only when it occurs near you, but when it occurs elsewhere?—Yes.

16863. It lessens the whole of the trade?—Yes.

16864. I suppose the trade would be willing, would they not, to undergo some little sacrifice in order to secure that the scare should never return; it would pay them to do so?—I should think so; it is no use.

16865. (*Sir William Ramsay.*) I suppose you are all combined; in the trade you all think the same thing?—Oh, yes; nothing sold at all, at least little, at any rate; you do not know what to do; you do not know in what way to commence in any shape or form.

16866. (*Chairman.*) Have you got any remedy in your own mind that you could suggest?—Well, there are remedies, of course. For instance, I supply the town of Brighton, and I supply the Métropole. I supplied the Grand Hotel until the wholesale people would not let me supply them any more. "Mr. Brazier, you are a wholesale man, you must not sell retail." That is the reason I was knocked off the Grand Hotel. I had supplied them for many years. But I do think this, my Lord, there is room for improvement in a good inspector

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to inspect, not only fishmongers' shops, but every barrow or wherever oysters are sold, but he must be an inspector in every sense of the word. Oysters lying in fishmongers' shops I should condemn if I were an officer. Billingsgate—perhaps lying in Billingsgate two or three days, it may be sent down to Brighton, lying in fishmongers' shops another week before they are sold; if those oysters are not fresh enough to be sent to table they must go for sauce. I maintain these oysters are bad—not fit to be sent out.

16867. You rather think, as I understand, that it is just possible that your oyster beds may get some of the Shoreham sewage?—Well, it is just possible, but, as I said before, I do not really see how they can; but still there is just that doubt; if there is any, that is where it comes from—must be.

16868. Would you say that Shoreham ought to take some steps?—Decidedly so, my Lord, they ought to take steps.

16869. Shoreham ought to take steps?—Shoreham ought to take steps.

16870. To improve their sewage?—To improve their sewage. They ought to take steps, there is no mistake about that.

16871. You do not think that you yourself could do any good to yourself—I am only talking of your own interests—by constructing storage ponds further back in the estuary?—I do not see that I could better it. As I said before, storage ponds are about 400 yards from the harbour's mouth, as it were. There are two flowing tides come into the harbour every 24 hours, which you know, and the ponds themselves, there is always a flood and an ebb tide, a continual stream going over them; they are kept perfectly clean.

16872. (*Colonel Harding.*) And you have not, as a fact, considered the question of removing those beds to a new site?—We do not know where to remove them, sir. I do not know of a better site.

16873. Are there no positions in the neighbourhood where they would be free from drainage contamination or the suspicion of it?—No, sir. There is the Southwick arm, and still free from any drainage at Southwick; there is Shoreham, they are not drained, they drain into the river at half ebb, when the tide runs about six or seven knots an hour.

16874. Are we to take it, in your opinion, that there is but this one site available?—That is all in Southwick, sir; it is not a very large harbour.

16875. But within a mile or two miles from that position could you not find a safe laying for oysters?—There is not, except this little bit, to lay oysters on; they have been lying there for about 60 years.

16876. What might be the cost of removing them?—Well, we could not remove them; there is no place to remove them to in the harbour.

16877. No other site available?—No other site available, sir.

16878. (*Chairman.*) Do you know whether they take mussels from Shoreham?—They do take mussels from Shoreham, oh, yes.

16879. Mussels that are near the sewage outfall at Shoreham?—I believe they are that. We do not trade in them, we have no mussels in our arm at all; they will not grow there.

16880. (*Sir Michael Foster.*) They will not grow in your arm?—No, sir.

16881. But the oysters do well there?—Oysters do well there, sir. Unfortunately we get the credit for things we do not deal in at all.

16882. (*Dr. Burn Russell.*) Have you both oyster beds and oyster layings?—Well, I do not know.

16883. I see on this map here, "oyster layings" in the South Channel?—That is right, sir; that is what we call the oyster ponds.

16884. Then I see close in there "oyster beds"?—That is the beds, sir. They are quite a trouble at any time to get out there, and they are kept perfectly clean; there is no sewage in any shape or form goes through them.

16885. Do you pay any rent for the use of this shore for the oyster ponds?—For the oyster ponds, but the beds, it is my own property, my own freehold ground.

16886. Who gets the rent for the oyster beds?—Colonel Carr Lloyd; Messrs. Upperton and Bacon are the solicitors, Pavilion Buildings, Brighton.

16887. It is a private owner?—It is Colonel Carr Lloyd. I believe Lancing is his Hall.

16888. Have they to get the permission of any public body—the Board of Trade or anybody—for the use of these?—Not at all, sir, it is Colonel Carr Lloyd's property. All the main beach along there is his property, and I may say these oyster beds run close to the main beach; it is the main beach that parts the main sea and our ponds.

Mr. JOHN KENNETT, Emsworth, called; and Examined.

Mr. J. Kennett.

16889. You are Mr. Kennett, and you own several oyster ponds on the foreshore at Emsworth?—Yes, my Lord.

16890. May I ask whether you get your oysters from abroad or whether they are English oysters only?—No; off the French coast, sir, about 40 miles, so you might call them English oysters. They are caught in the English Channel, and brought into Emsworth by vessels.

16891. And they reach you in a vessel?—In a vessel, in a welled vessel, a welled boat.

16892. And then you store them?—We store them.

16893. In your ponds?—Yes.

16894. And do you store in your ponds oysters from Whitstable and other places in England?—Yes, we store Whitstable oysters.

16895. Do you own the ponds that you use, or do you rent them?—Own them, my Lord.

16896. And you distribute the oysters from your ponds all over the South of England, I suppose?—Yes.

16897. How long are the oysters stored in your ponds?—Well, to such times as we have the demand to sell them. We have large quantities come into Emsworth every week; we have got, I suppose, the largest fleet of dredging boats along the coast, and we have them continually coming in from September up till June, and we keep on selling them.

16898. Would you say that on an average you would keep an oyster three months in your ponds?—No; we should not do that.

16899. Not so long?—Not so long as that.

16900. (*Sir Michael Foster.*) A month?—Yes, we should do a month.

16901. (*Sir William Ramsay.*) Do you keep them from spring to winter, again; in summer do you get them all off?—Then we take them to Hayling Island; we have got what we call summer beds down there.

16902. (*Sir Michael Foster.*) You take them all down there?—We take them all down there, sir, and bring them up as we want to use them, because there is not such a demand for them in the summer as there is in the winter. For a certain class of oysters we have to take them down there, and we let them be; they stay there until the fall of the year.

16903. (*Chairman.*) How many people, about, would there be engaged in the shell fish industry in Emsworth?—Something like—men, well, young men, I should say nothing less than 200.

16904. Do you do much business in scallops and winkles, and mussels?—Oh, yes; not mussels, but winkles; we go in for a large quantity of winkles.

16905. Scallops?—Scallops; we did when the scallops were found on the French coast. Then we had the boats running direct to Emsworth, and then we did not store scallops, we sent them direct from the boats to the markets. But now, you see, the scallops giving out over in France, or in the English Channel, we go up between Dover and Cale catching scallops now, and they run into Newhaven, so we do not do so much in scallops.

16906. You do not do so much in scallops?—No.

16907. Now, I suppose when you send oysters, and anything, to market you send them in sacks and bags?—We send them in bags, and also in barrels supplied.

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16908. Where do you get the bags and the sacks?—We buy them from the bag-makers in London.

16909. How far from the main Emsworth sewer are your nearest ponds?—The nearest pond that we use is somewhere like 50 yards; there are some marked on the map, you will see, that show almost close to it, but they are not used; they are old beds that have been there, but they have not been used for numbers of years; there are some of these marked very close there; very close.

16910. (*Colonel Harding.*) The drains are there still?—The drains are there, but you must remember, sir, when the drain was put there it was only to be for a surface drain.

16911. That is the drain from Tower Street?—From Tower Street; there is no drain there now.

16912. But there is a drain which seems to follow there from Tower Street, and come into the middle of these beds?—No; there is one main drain comes right along the foreshore, and picks up all these little ones; there is no drain whatever along the foreshore.

16913. (*Chairman.*) You would say the nearest pond was about 50 yards from the main outfall?—Yes, my Lord.

16914. The sea comes right up to the main outfall?—Oh, yes, and covers the oyster bed. You see the main outfall; the beds might be like the inkstand and the main outfall down here, much higher than that, though, in comparison, and then we have eight feet of water twice a day that is, every six hours, and spring tides over these beds, that there is, and that body of water all over these beds twice in 24 hours.

16915. And, of course, with that body of water, just over the beds, must be mixed the sewage unfortunately?—You see it would not have so much effect. I do not believe it affects the oysters one iota, because there is not sufficient, what they call sewage, comes out of the drain as is represented for a very little; I should say a four-inch pipe would take all there is comes out there. That is an 18-inch pipe shown there, no doubt. Dr. Bulstrode knows; he has been down there.

16916. How long has the main outfall been where it is now?—Where it is at the present time; I think about 27 years.

16917. And how long have your ponds been there?—Oh, hundreds of years.

16918. Have you ever had either your fish or your water analysed?—No; not till this outbreak; not until the scare broke out this time.

16919. You have had it analysed?—It was analysed, yes.

16920. By whom?—By one medical officer of health in London; I forget his name now.

16921. Have you had any communication from him?—No; none whatever.

16922. You do not know whether he found the result satisfactory or otherwise?—Well, they said there was a little contamination in the water, but nothing to speak about.

16923. Who communicated that to you; the Medical Officer of Health himself, did he?—No; when we had the oyster merchants meeting, my Lord, in London he represented it at the meeting. He gave different places—Bosham, Whitstable, and so he did Emsworth, four or five places, Southwick.

16924. How long have you managed the beds yourself; I mean how many years' experience have you?—Thirty years, my Lord; I have had a life experience in oysters—a life experience.

16925. Is this the first time there has ever been trouble?—The first time in my memory, my Lord; or that there has ever been in Emsworth; I can go so far as ever. The oysters have always had a great name. It did not matter what part of England you went to, you would always see Emsworth oysters marked up in the shop. We are far beyond Whitstable for the name.

16926. Have you any suggestions that you can make for remedying the present state of things?—My suggestions would be: the oyster layings and the oyster beds were situated differently from the oyster layings in the south coast; different to what the Whitstables or the Sea Salters are, because ours are oyster beds made square, and we lie upon high ground, and therefore we want to be protected from these drains which the local councils allow to run into the river. We want that stopped, and then we should have everything all clean and pure.

16927. (*Sir Michael Foster.*) What is to be done with the sewage of the place?—Why, let them have a system of sewage; a system of drainage.

16928. (*Sir William Ramsay.*) Where would you carry it here?—We can take it over—well, I should say about a quarter of a mile over in some mud land that has been taken in, oh! hundreds of acres; and that land is much lower than our ponds are, and they can do it very easily, and not have any contamination whatever.

16929. (*Major-General Carey.*) Could not your ponds be raised above the level of the outfall?—Feet, sir.

16930. Where they are now?—Yes, feet.

16931. Could they be raised above the level so that the sewage could not get at them?—No, because you see we have such a high rise in depth of the sea water.

16932. (*Sir Michael Foster.*) They are much above the level of the outfall now?—Oh, feet; I should say something like six feet; take from the level of the outfall to the level of the oyster beds, I should say quite six feet.

16933. (*Colonel Harding.*) Still, the tide washes over them?—Well, the tide comes over them, but you see our current of tide. Here is the outfall here, and here is our harbour, you see; well, when the tide goes out that takes it right away down.

16934. (*Sir Michael Foster.*) How are your beds made?—Square, sir.

16935. With a gravel bottom?—With a shingle bottom.

16936. With a shingle bottom and oak sides?—And oak sides, yes.

16937. How much money is invested in the construction of the beds, do you think?—Well, each bed, according to the size, costs about £6 each; some of them cost £20; some would cost £30.

16938. How much would it cost to move your beds altogether to a different position?—Well, I do not know where you could move them to.

16939. There is nowhere another position?—There is nowhere to move them, because, you see, there is no such place along the south coast as Emsworth is for the fishing industry.

16940. But near Emsworth itself; instead of moving the sewage, can you not move away from the sewage?—No, we cannot, unless they move right away down to Hayling, which is nothing in comparison, which is very awkward. You could not do it.

16941. What are the advantages of your position in Emsworth?—Advantage; why, the vessels, you see, sir, can come up close to Emsworth.

16942. Close to your beds?—Close to the oyster beds. All we have to do is to put a large boat alongside, board them into the boat, then we come and put them into each bed just as we want them. Then it is always handy for the winkles, sir. The winkle industry at Emsworth is one of the most valuable and important fisheries there is in the south of England.

16943. And there is positively no place at Emsworth except the very spot where you have got your beds?—No, sir, there is not.

16944. (*Dr. Burn Russell.*) You store winkles also?—We store winkles for a time, sir. We have got a vessel that is right up on the foreshore; that is, with a false bottom under, as that might be. Here is the bottom of the vessel; two large holes are cut in; there is the false bottom put there, with all iron bars across, like that; and we buy these winkles as the men and boys bring them up; so we buy them and store them in this boat, and then we pack them up and send them away.

16945. Where do they come from?—Off the muds, about five miles, sometimes ten miles in different harbours. You see, in Emsworth there are two different harbours that they can go and pick up these winkles. There are acres, oh, hundreds of acres of mud; they do not get them on the sand the same as they would in Ireland or Scotland or anywhere else; they pick them off the sand there, but here we pick them off mud. They are supposed to be the best winkles there is down there though.

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16946. Are these, the mud banks on which you get the winkles—are they clean?—Oh, yes.

16947. And not exposed to sewage?—No, sir; it is all grass, like the grass in the field, which grows on top of the mud; it is the very same thing.

16948. A sea grass?—A sea grass, and the winkles eat it.

16949. But you are quite sure that it is clean?—Oh, yes, perfectly.

16950. (*Major-General Carey.*) What are the District Council doing; are they going to do anything?—Well, they have been talking so long they were going to move this drain, but I complained to the Local Government Board in 1895 about the drain, and they gave orders then to move it, but they never took any notice; they went on considering. I am on the Council. They kept on considering different schemes of drainage, and when the Local Government Board wrote down as to what they were doing, yes, they were considering it; and that is how it has been for many years.

Sir William Pink and Mr. St. Barbe, called in; and Examined.

Sir W. Pink and Mr. St. Barbe.

16951. (*Chairman.*) Sir William Pink, you come to us representing the Southern Sea Fisheries District?—(*Sir William Pink.*) Yes, my Lord.

16952. Will you state the limits of your jurisdiction?—The limits of our jurisdiction are the territorial waters of the coasts of the counties of Hants and Dorset, including the Isle of Wight.

16953. And how far up the several estuaries does your jurisdiction extend?—That, sir, is limited to certain estuaries. In the greater number of cases—in the common number of cases our jurisdiction extends as far as the tidal waters extend, but there are in the district one or two exceptions to that. For instance, the harbour of Southampton. The Southampton Water is outside our jurisdiction, as being under the Harbour Authority. In nearly all the estuaries that we take in we run up to the limits of the tidal water.

16954. This morning we have had two witnesses from Poole, Mr. Cole and Mr. Scott, who use ponds at Poole. Does your jurisdiction extend over those ponds?—Yes. With regard to Poole Harbour it has been under consideration for some time whether we should not take an order for working the oyster beds at Poole and at Hamworthy, just by Poole, and also Poole itself.

16955. What staff have you got?—(*Mr. St. Barbe.*) I am the clerk. We have one fishery officer at present.

16956. And you have ample facilities for visiting the fisheries?—(*Sir William Pink.*) What we really think about this is we have not quite what we ought to have, because we have not been enabled to spend much money about it, but we have made a rather rough report of the sewage of the districts, and we can if we had time—of course, our large district is divided into several smaller ones; we could get actually the number of houses that are attached to the drains that run run into the sea. But what I wanted to say, if I may be allowed to do so, is in the first place to emphasise the drainage of Emsworth and that district, because it is near to Portsmouth, where I live, and there has been a good deal of sickness there from the oysters which have been taken, and that is just inside the Sussex district, but Portsmouth takes most of the oysters that are bred and taken at Emsworth, and there is no doubt at all that Emsworth drainage has been very detrimental indeed to the fishing interests. Well, now, this is what our officer says with regard to Poole Harbour:—"Proximity of sewers to oyster beds at Lower Hamworthy. Sewers serving a small cluster of houses discharge within from 50 to 100 yards of two oyster beds. No ready market for these oysters." In fact, that is the case with regard to all the oysters around the South of England. Now their trade is almost entirely stopped. The report of the Dorset Medical Officer of Health also includes a reference to the Lower Hamworthy sewer, but there is a possibility of this matter being dealt with by the Board of Trade in granting an order to the Local Fisheries Committee for the regulation of the Shell Fisheries within the Harbour. This order will give us powers for taking over the fisheries at Poole Harbour and working them instead of the Poole Corporation. Well, there is not a great deal to complain of in the West; I do not think anything worth speaking of, because there are very few shellfish there, but the most serious matter outside of Emsworth seems to be in the Isle of Wight—Wootton Creek, in the Isle of Wight; the population there is about 1,000, scattered about in the neighbourhood, and there are several small sewers constantly flowing, I am not quite certain how many houses there are drain into these sewers, but they constantly flow on to the mud on the beach and the mud all round an oyster fishery and oyster beds there. And then small yachts are laid by there occasionally, and a man of the name of Ayles has a shipyard in the creek, and from his yard there are two drains, and they run out 15 yards from the oyster beds. They say the oysters sell from these beds to the surrounding country and neighbourhood, and at the present time these small fishermen have about £500 worth of stock which they are unable to place upon the market at all. The Medina oysters are also in the proximity of sewers at Cowes. And with regard to Lymington, they have a sewer there. There are eight fishermen and some oyster fishing; the sewers are some hundreds of yards off. There is an exposed beach about 700 yards from the oyster beds. What I should like to say is that, generally speaking, all along the coast there are a good many houses that drain into the foreshore and in creeks and small places like that; I think it is very detrimental indeed where these houses are attached to drains, and zymotic diseases take place there. The effluent flowing out into the sea and over the oyster beds seems very objectionable indeed, and I think very dangerous.

16957. Have you got any facilities for bacteriological or chemical examinations?—No, we have not really anything of that kind at the present time nearer than Plymouth; at Plymouth they have, but not in our districts.

16958. Is there any Medical Officer of Health who is officially entitled to advise you?—Not to us as a Fishery Committee. We have the Medical Officer of Portsmouth, who has really examined these bacterially, and he has pronounced them dangerous.

16959. Have your committee taken any action to protect the shell fish from pollution?—No, only in respect to throwing objectionable matter and rubbish into the sea and Poole Harbour, but not generally.

16960. Do you know at all how many persons in your district there are who are engaged in the shell fish industry?—I could find out; I am not quite certain how many. (*Mr. St. Barbe.*) There is a limited number of fishermen. The oyster fishery is practically, in our district, confined, well, almost to the Solent and Poole Harbour. There is a considerable number of boats, I think about 24, at Poole Harbour, but at the various points within the Solent there may be perhaps four different points averaging about eight boats apiece; it is not more than that. The fishing is not really very important, Poole Harbour fishery being the only important oyster fishery in our district.

16961. Now, has it been your practice when there has been a Local Government Board inquiry as to sewage disposal to attend and place before the inspector the conditions as to shell fish distribution?—(*Sir William Pink.*) I do not think so. (*Mr. St. Barbe.*) The practice in all Fishery Committees is this: we do not have any official notice of the inquiry by the Local Government Board at all, but we always hear either before or after—I think it usually comes before—the Local Government Board inquiry; we have a notice from the Board of Trade sending us the plans which have been deposited by the promoters of the scheme, and we are invited independently to make our observations on the scheme, and from the point of view of the fishing, and report to the Board of Trade. The Board of Trade merely inform us that the Local Government Board are holding an inquiry, but we have no official information of that, and it has not been the habit to attend.

16962. (*Sir Michael Foster.*) You report merely to the Board of Trade; you do not attend the inquiry itself?—We report to the Board of Trade; we do not attend the inquiry.

16963. (*Chairman.*) I take it, as far as your actual powers are concerned, they are very limited?—Yes.

16964. If you knew there was a polluted source, would you prevent shell fish being taken from the place?—(*Mr. St. Barbe.*) We have power under the Act to regulate the taking of fish by any means, but I question

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whether the Act—I do not know whether it has ever been tried in the other districts. I do not think it is what is intended by the Act, although it might possibly cover it. We have never tried it. There is a power in the Act to prohibit, either entirely or by any specified means, the taking of any specified sorts of fish. These are almost the words of the Act, I think. I have not got it here. I do not think it is intended to cover that point, but I have no doubt it might be in the Act of 1888.

16965. (*Sir Michael Foster.*) In practice you have never used that?—No, sir, not in that way, not for this purpose.

16966. Could you find it in the Act; that is the Act (*handing Act to witness*)?—Yes; I was going to say I think I ought to modify my last reply. My memory was not quite good enough, and it has occurred to me since that is hardly accurate. As to our powers for prohibiting fishing entirely in that sort of way, I think we have not, now I come to think of it, for this very reason, we are now applying, or rather the Board of Trade are going to grant us powers over one particular district, namely, Poole Harbour, in order to enable us to do those things amongst others, therefore I do not think we have power. No, I thought that the special Section A covered it, but I was speaking from memory only.

16967. That is limited entirely to fish properly so called, is it not?—Oh, I think it includes shell fish.

16968. Does it?—Oh, yes, sir; we have made bye-laws under that section with regard to shell fish.

16969. I see in the resolution which your committee passed on December 17th of last year, you recommend: "That in all cases where there exists an organised system of drainage for urban or rural sanitary districts, the crude sewage should be efficiently treated by some septic or other process before discharge into the sea." What do you exactly mean by "efficiently"?—(*Sir William Pink.*) Well, what we mean by "efficiently" is that it should not be allowed to flow into the sea without being treated in some way to prevent any ill effects. We are not supposing that crude sewage was from closets where patients were suffering from typhoid fever or anything of that sort.

16970. That is to say, your "efficiently" would include the destruction of all the germs of disease?—Of disease as far as possible.

16971. Do you know of any septic or other processes which will effect that?—I believe that the septic tank really if efficiently put up—the two friendly, the anærobe and the ærobe will act upon this sewage; at least, that is the belief of many of us, that it will effectually destroy any bacteria that may be prejudicial.

16972. Would you be surprised to learn that that belief is baseless?—Well, I should be rather surprised to learn that. It will not take me a moment; may I tell you exactly how this sort of thing works? Without any very large expense in my own case, I had difficulty from my own house in treating or getting rid of the sewage; I have a chalk formation, the subsoil is chalk. I had two deep pits sunk into the chalk, and the drainage from the first of these was more than that could soak away, went into the second, then that which the second could not take flowed on and was used for irrigation. Now it is a singular thing that passing through both of these beds and then flowing over, the effluent was almost innocuous and almost pure in colour, and so far as I know I could not possibly say that it did not contain bacteria that would be prejudicial, but I do not think it did.

16973. Did you have it examined bacteriologically?—No, I did not, but I did this: it was an extraordinary thing that these beds when cleaned out, from a manurial point of view, they were almost valueless, showing really that the ærobes and the anærobes had efficiently done the work; at least, that was the conclusion I had to come to.

16974. You are not aware that in all these various processes, although there may be some reduction of micro-organisms, the effluent, although it may be apparently perfectly clear and chemically pure, still may contain a very considerable number of organisms, some of which may be pathogenic?—I understand so, but I had not known it of my own knowledge. I had read of it, at all events; do you think it is really so, sir?

16975. Yes?—May I just say that, if it would be valuable for the Commission to know, we can make further inquiries the whole of the district round, and any particulars you wish to know from the district, we will find out and send you up.

16976. (*Chairman.*) Thank you; we had better let you know if there is anything we want?—(*Mr. St. Barbe.*) I told my chairman, as a matter of fact, we have never had a systematic examination of the district from this point of view, and the notice we have had of our invitation to come here has not given us time to do it. A more systematic examination could be easily made, and of course we should very much have preferred it if we had been able to do it. I wish to explain that. (*Sir William Pink.*) If we hear from you we will prepare anything.

16977. Thank you very much.

FIFTY-EIGHTH DAY.

Tuesday, 12th May 1903.

PRESENT:

The Right Honourable The Earl of IDDESLEIGH (*Chairman*).

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P.
Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary.*

ALSO PRESENT—

Dr. A. C. HOUSTON, M.D.
Dr. BULSTRODE.

Mr. G. H. Baxter.

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Mr. G. H. BAXTER (representing the Chamber of Fisheries), called in; and Examined.

16978. (*Chairman.*) You are Mr. Baxter, and you come to us representing the Chamber of Fisheries?—That is so.

16979. Now, let me ask you this leading question, does your experience teach you that it is possible for typhoid fever to be conveyed to human beings by oysters which are contaminated by sewage?—Well, I cannot say I mean my experience teaches me that it is not possible to convey it, but still one does not want to go against the scientific men, bacteriologists and those people, and set one's own opinion up, which is not of course a qualified one, but if it were a common occurrence for typhoid fever to be communicated by shellfish, I think we should find, perhaps, 75 to 90 per cent. of people in England or one may say in Europe suffering from typhoid fever.

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16980. Then shall we say that you are sceptical on the subject?—No, I think I can go further than that; I think you can say that I am quite an unbeliever. My opinion is not in the balance either way. If I were asked for my unbiassed opinion, I should say it was practically impossible for it to be communicated by shellfish.

16981. For typhoid fever to be communicated?—Yes.

16982. Thank you?—I mean, mine would be very likely a biassed opinion; it might be.

16983. Yes, but the inclination of your mind is to think that typhoid fever never has been conveyed by contaminated oysters?—That is asking me to commit myself rather.

16984. (*Sir Michael Foster.*) But you said it was impossible just now?—In my opinion it is impossible.

16985. Impossible?—But, of course, there might be one case where the exception would prove the rule.

16986. But do you really mean that it is impossible for the typhoid germ to be conveyed from sewage through an oyster to a human being?—In my opinion—as I say, I do not wish to set my opinion again scientists—but in my opinion, practically, of course, my experience extends over a great many years. I have never known a case in which it was absolutely proved yet, of course, there is strong circumstantial evidence.

16987. (*Chairman.*) Well, may we take it in this way from you, that at any rate you consider the danger excessively remote, that there is no need to take precautions against it?—I do not say that there is no need to take precautions against it. I may say that it is not the typhoid fever that I fear but from an æsthetic point of view I object to fisheries, whether oyster fisheries, or any sort, being contaminated by sewage matter. It is not pleasant to think that we are really eating anything which is contaminated with sewage.

16988. Well, then, if you are of opinion that it is desirable to prevent fisheries, shellfish, or otherwise, being contaminated by sewage, could you give us any remedies that you would propose to prevent contamination?—In my own idea of course the sewage should never be discharged without treatment near any fishery, or in fact near any inhabited town on the coast, it should be treated, either by septic tanks or sewage farms so that the effluents would do no damage, would not pollute anything at all. It is possible of course, and in fact I know it is approved by the Local Government Board because I had a good deal of experience with them—the sewage farm and the septic tank. Now the sewage is discharged in a crude state at most of our health resorts, or watering places.

16989. Well, but are you aware that it is pretty well ascertained now that an effluent either from a sewage farm or from other systems of filtration may still contain large numbers of noxious bacteria?—I believe not if it is properly treated.

16990. (*Sir Michael Foster.*) May I ask what you mean by "properly treated"?—Well, the septic tank, of course, is approved, I think. Well, in fact, I know it is approved by the Local Government Board. It has been in use at Exeter now I should think for about seven years; the effluent after being flowed over land, does not affect the fish life, and sewage I think, in the streams always kills the fish there. Trout will thrive in the streams where the effluent is discharged.

16991. Yes, but the bacteriological examination of the effluents from septic tanks, has proved that a very large number of organisms, some of which may be injurious, are present?—Well, that I think, is a question whether they are injurious or not. I do not know that any bacteriologist will swear to any bacillus that he found; of course, they have very striking likenesses, and by their growth in the cultivating media they are able to tell fairly well what they are, but they cannot swear to them. I think if you get a bacteriologist to examine anything for you that is supposed to be contaminated by sewage, if you were to put him on his oath he would not swear that it was *coli communis.*

16992. (*Chairman.*) All I would ask you is to make any suggestions that have occurred to you to the Commission?—Well, of course, the discharge of crude sewage I object to most decidedly, and I think that might be remedied by a better system of drainage, and another thing, in the ports and harbours in the vessels that are coming there—I suppose you would not call it sewage then, but fœcal matter, is discharged directly from those boats into the harbours, and is about in those places—well, for days one may say. And certainly I object to sewage being discharged crude, for instance, as it is at Southend, and at Bournemouth, places like that—I mean the outfall of the sewer is within a very short distance of the shore. The Medical Officer of Health for Southend some months ago now, attending a meeting of medical officers of health, spoke very strongly on sewage pollution. He said that anybody handling oysters or anything of the sort, if they put their hands to their mouths stood great danger, or were in great danger of having typhoid fever communicated to them in that way. Well, suppose that were admitted, is it not very much more dangerous for people bathing on those places. They cannot very well bathe in the sea without getting a certain amount of water in their mouths or down their throats, and they water the roads with the water from the sea so that I think that if one admits that typhoid fever is conveyed by oysters and shellfish generally it would be much more likely to be conveyed by bathing in these waters, and by watering the streets with the water which is nothing but sewage, one may say dilute sewage. So that I mean apart from the danger to fisheries, I think the danger to public health is larger, is more than it is from the fisheries themselves. I believe the Local Government Board approved of the Southend scheme.

16993. (*Sir Michael Foster.*) Your position is then, do I understand, that crude sewage should not be discharged into the sea at all, not even if carried to a considerable distance from the shore. You were just now speaking of cases where the sewage was discharged not far from the shore?—Yes.

16994. Would any distance from the shore satisfy you?—Well, it would have to run into at least 100 miles I should say then you do not pollute the oyster fisheries because there are none so far from the shore, but if oysters and mussels and cockles and periwinkles are polluted, why should not the other fish, such as lobsters, soles, plaice, and all those things be polluted by it. If the water is polluted at all, these things are constantly having water through their gills so one may expect everything to be polluted, so I think it is a great mistake to discharge crude sewage into the sea.

16995. There is no power of purification by means of the sea and its inhabitants?—According to bacteriologists no.

16996. Is the sea gradually getting more and more impure then from the amount of sewage which has been discharged into it?—Well, I should say it is, certainly, near the coast, because, I mean, now even from the Maplin sands, cockles taken from the Maplin sands have been found to be polluted with what is supposed to be *coli communis.*

16997. Then the discharge into the sea being in your opinion not permissible, the sewage should be thrown upon land, and you would be content with land filtration by a sewage farm?—Well, one I suppose must be content with that as it is approved by the Local Government Board, which is the sanitary authority

16998. But you do not approve of it, I gather?—Oh, I approve of it myself, only you were questioning that just now.

16999. You approve of it?—Decidedly.

17000. That would satisfy you?—That would satisfy me.

17001. But where there is no land available for the purpose, because of course filtration on a land farm requires land of a certain quality, or is very imperfect if the land is of certain other quality; then I understand you would be satisfied with the septic tank?—With the septic tank and a smaller quantity of land for it to be flowed over.

17002. With the septic tank alone?—Well, I should not like to say I should be perfectly satisfied with the septic tank alone.

17003. Does the septic tank, remove the objections from an æsthetic point of view which I understand is your chief objection?—Well, from an æsthetic point of view perhaps it might, but one would be more satisfied if it went over land

17004. There is something——?—Well, to a certain extent; say, I qualified that I think to a certain extent, it would be better than discharging it crude, but one would be more satisfied if it flowed over land, because it must to all intents and purposes be pure.

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17005. Or by any other method which would give a result as good as that of land; that would satisfy you?—Yes.

17006. Have you any suggestions to make as to how that would be brought about?—Do you mean how the expense should be borne?

17007. Yes?—By the municipal authorities one would say naturally. One could scarcely expect the Government to take it up, but I suppose one could not expect Government to pay for these things, but the municipal authorities should certainly do it, because it is rather a case of cutting their own throats destroying these fisheries. At Brightlingsea for instance; if the fishery is closed there it means throwing some 700 or 800 people out of work, which means a burden on the ratepayers.

17008. You do not think the country has any claim whatever to a contribution from the fisheries themselves?—Most decidedly not. The fisheries were, I may say, all of them, established long before sewage was known. It is the sewage which has been brought to the fishery, not the fishery to the sewage.

17009. And the fisheries have you think, complete right over the whole stream?—Decidedly; in most cases of course, we know there have been some later grants, but the old-established fisheries; the more modern grants of fisheries are very very few indeed.

17010. And that the fisheries where they have vested interests have complete command of the streams in which the fisheries are?—In most cases.

17011. To what authority would you entrust the power to decide that the sewage does not injure the fisheries?—Well, the only authority of course that we could entrust it to now would be the Local Government Board.

7012. And you would be willing to entrust it to them?—It depends upon the nature of the Bill that would be brought in giving them power.

17013. You remember there was a Bill brought in in 1899 with regard to certain points of your industry?—Yes.

17014. And that Bill provided that the administration should be by the Local Government Board, or by the sanitary authorities, and in the House of Lords I think it was, there was an amendment by which the power was transferred to the Fishery Boards?—To the Fishery Boards.

17015. Yes, to the Fishery Boards or Committees?—The local fishery committees.

17016. Yes?—Well, that was, I think, because the original Bill entrusted the whole thing to the local medical.

17017. You would not insist upon that in this matter; you would be willing to entrust the supervision to the Local Government Board, and to the sanitary authority? As far as we can tell at present, of course, it depends entirely on the nature of the Bill, and what power is given.

17018. You would not press forward as a general principle that the Fishery Committees should be the authorities in such cases?—I could not give you any answer to that question until I saw the Bill itself. You see, I mean it altogether depends upon what the Bill embraces as to whether it would get the support of people who are interested or not.

17019. Besides the shell-fish which are grown upon our own shores, a large number of shell-fish are imported, are they not?—Yes.

17020. Some of them for direct consumption?—Yes.

17021. Not only oysters, but cockles and mussels?—Yes, not a great many cockles but mussels, a very large quantity.

17022. A considerable quantity of mussels?—A considerable quantity.

17023. Coming from Holland?—From Holland.

17024. Chiefly, or to a large extent from Holland?—I think I may say entirely from Holland now; we have not had them from Belgium for many years.

17025. Do you think there is any danger to the public health in those shellfish?—No. In Holland of course all these beds belong to the Dutch Government and they are let by tender, and it is to the interest of the Dutch Government to see that these beds are kept perfectly free from pollution. They could not drain on to the beds on account of the land being lower than the sea; there is no such thing as sewage known in Holland, the whole sewage matter is used on the land itself. There is a periodical inspection of these oyster and mussel fisheries by the Government bacteriologist, I think from the water works in Holland, and they are sent to the Dutch Government periodically, and as far as we have had them at present—we have them ourselves—they are perfectly free from pollution. They have been examined in London by Dr. Klein and pronounced perfectly pure.

17026. Do they come over the whole year?—No, no, the mussels commence about the end of August.

17027. Then is there a close season, so to speak, in which there are no mussels?—Well, they are not brought into England because they would not sell; they would not be fat; they would be really out of season.

17028. That is to say they are not brought in because there would be no sale for them?—No sale for them.

17029. And the season in which they are not brought in extends from?—Well, about this month until about August.

17030. And during that time practically no mussels come over from Holland?—Practically no mussels. Then there are periwinkles of course from Holland in very large quantities.

17031. All the year round, or is there a close season for them?—Well, there is no close season, but one may say that in the summer very very few come.

17032. And are they also so to say guaranteed by the Dutch Government?—Yes.

17033. As being free from pollution?—Yes: as being free from pollution.

17034. Of the American oysters a certain number, a very considerable proportion, are sold at once for consumption, I think?—Yes.

17035. And another portion is laid down in various points of the British Coast?—Yes.

17036. Are they guaranteed by the American Government?—Well, the American Government—now—

17037. I will not say the Government, but has the British consumer any guarantee that the oysters as despatched from America are free from pollution?—Well, they have no more guarantee than we have from our better class of oysters in England that the producers are doing all that they can to keep their beds pure, and that the sanitary authorities in America are doing the same thing. They are just as careful over them as we are trying to be now in England.

17038. And with regard to the French and Portuguese oysters, does the same hold good there, too?—Well, the Portuguese oysters, we rarely get any that are sold direct, they are relaid on our English beds. Most of the French are; a few French are sold here, but as a rule the French are not fat enough to sell when they come over.

17039. Is there any reason to believe that these Portuguese oysters are polluted when they come over. There was some evidence to that effect when that Bill was under consideration I think, was there not?—Yes, I think there was.

17040. And was there not a demand that they should be put into quarantine for a certain time in order to ascertain whether or not they were injurious?—But the idea was that all foreign oysters should be put into quarantine.

17041. For security's sake?—Which would be unfair, I mean. Yes, but I do not know; the Portuguese oyster is an oyster which one would not like to say very much about. I have had them examined from beds lying, it might be the native oysters would be lying in this place and the Portuguese here, so that there would be nothing really between. The native oysters have been pronounced perfectly pure, and the Portuguese oysters have been looked upon with suspicion.

17042. After how long a stay in the bed?—Oh, months, months, three or four months. Oh, more than that, six months. That was only at the commencement of this year, and they had been laid since about March the year before, so that it would be more than six months—about nine or ten months, so that one can scarcely give any opinion upon the Portuguese oysters, I mean, why they should be polluted, and the native oysters not polluted.

17043. They have a very characteristic form, have they not, the Portuguese oyster?—Oh, yes. Oh, nobody could mistake a Portuguese oyster for anything else if they had once seen it.

17044. Do they have the same discharge of water through them that there is in the case of the native oyster or is the retention of the water within the shell for a longer time?—I think not.

17045. And you cannot account for this suspicious feature of the Portuguese oyster?—No.

17046. But apparently your attention has been called to it?—It has been called to it, oh, yes. Of course, the Portuguese oyster is not a true oyster at all.

17047. Would you allow the importation of these polluted oysters and shellfish to be perfectly free?—When one knew that they came from unpolluted sources, decidedly.

17048. Then you would demand a certain guarantee?—Yes, I think I might go so far.

17049. On the supposition that the polluted oyster is at least undesirable?—Oh yes.

17050. It would be unfair that the country should be put to great expense in order that the British oyster should be beyond suspicion, and yet the foreign oyster allowed to come in freely?—Unless it came from a source that was guaranteed; I should have no objection to it being restrictive.

17051. But would you admit it; would you admit all these various shellfish, oysters, cockles, periwinkles, and mussels without guarantee, supposing that the changes that you wish introduced are brought about for the purity of the British shellfish?—Would I admit them free whether they came from polluted or unpolluted sources, do you mean?

17052. Yes. Would it be fair that so much of the public money should be spent in protecting the public against the native-grown or native-laid shellfish without some guarantee to the public that the directly imported shellfish was equally free from suspicion?—I take it that by that you mean if we had a guarantee, as we have from the Dutch Government now that the oysters and mussels that we import from Holland are pure, you would not put any restriction upon those.

17053. That is what I mean; I mean you would insist upon some such guarantee before you admitted them into the British market?—The foreign oysters.

17054. Yes?—I think we should be justified in that.

17055. Would there not be more than justification; I mean would it not be your duty to see to it for the protection of the British public?—Well, you are, it seems to me, to be going back rather to protection, does it not, and that is a thing that the British public objects to nowadays. It is an illustration of free trade, I mean, one does not know exactly how to answer that question. Personally I should object to any oysters being placed on the English markets that were polluted, but I should make the polluting parties pay for any damage done to the owners and holders of the fisheries.

17056. At what rate would you reckon a human life in order to assess damages?—A human life?

17057. Yes?—Well, I think I have not at present ——

17058. Supposing, I meant?—Well, you see, in that case I cannot suppose it because I do not believe it; I do not believe it possible.

17059. Well, your æsthetic objection would be very slight, would it not?—I do not think so, if one's business was entirely ruined.

17060. No, but I mean your proposal was that the introducer of the polluted oyster or shellfish should be fined for the damage which he had done?—No, the man who pollutes the fishery. If a fishery is closed, I should agree with closing any polluted fishery, but not closing that fishery without compensation to the owner or holder.

17061. Yes, but we were speaking of the introduction of foreign shellfish, were we not?—Oh yes, with that I said I quite agree with you, unless we had some guarantee, as we get from the Dutch Government, that they are pure, unless they pass our own bacteriologists, I would put some restriction on them — decidedly — most decidedly.

17062. Quite so, that is the point I wanted to bring out, that you thought there should be a restriction on their importation, a restriction guaranteeing freedom from pollution?—That, I think, was the answer I gave you, and you were simply asking me to confirm that.

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17063. (*Mr. Stafford.*) You commenced your evidence by saying that you thought it was practically impossible to communicate typhoid fever through oysters, did you not?—Yes.

17064. Can you give me any reason for that opinion?—Well, I did not know I was coming here really to undergo an examination for scientific purposes, but I would have been primed, perhaps, on these matters a little more than I am, if I had, but I think the answer that I gave before that was, if it were possible or a common thing, of course, I think I did not say that it was impossible, because all things are possible, but if it were probable we should find about 25 per cent. of the people of the inhabitants of the British Isles suffering from typhoid fever, because, I think, at least 25 per cent. eat oysters, and they do not know from what sources they are obtained, some of them coming from sources that are known to be polluted.

17065. Do you consider that typhoid fever can be communicated by means of a bacillus?—Well, I should not like to answer that question. I think you will find a great many of our best doctors who will tell you that they do not believe in the bacillus theory at all.

17066. Do you consider that typhoid fever can be communicated through water?—One has every reason to believe it can.

17067. Then why not through oysters? If the bacillus can find its way into water, why can it not find its way into oysters laid in certain polluted waters?—I do not know whether you know the habit of the oyster at all. The oyster in its natural state, when they are covered by water, has a series of fins with celia on them. I do not know how many millions, it has been counted I believe; but I do not know how many millions, which are constantly working, and there is a constant current of water through the gills and through the whole of the oyster, and they throw off anything that they do not feed on.

17068. Supposing you had oysters kept in polluted water which contained a bacillus, would not that bacillus find its way into the oyster, and into the surroundings of the oyster?—I suppose it would be possible for it to do that but the question is whether it would have any power of communicating disease after it had been through the oyster.

17069. But you agree with me that typhoid fever can be communicated through water; why not through the polluted water of the oyster?—The question is whether the water is polluted when it has been through the oyster; whether the oyster does not throw off the pollution.

17070. (*Sir Michael Foster.*) But when you eat an oyster you swallow also the fluid which is outside the pallail chamber as well as that which is inside, and then the bacillus is so small that it would pass through the bars of the gills into the branchial chamber, although the somewhat larger particles are thrown off by the cilia and the labia?—Yes.

17071. So that when you eat an oyster you certainly have a chance of swallowing the minute organisms which are present in the water which have entered between the valves of the shell and remain in the oyster at the time when he is taken up?—The question is whether the bacillus has been killed or rendered innocuous by being in the shell of the oyster.

17072. (*Mr. Stafford.*) Have you any reason to believe that it may be?—There have been some very interesting experiments carried out with the cultivation of the bacillus in the oyster by Dr. Cartwright Wood, some years ago now.

17073. And what conclusion does he come to about it?—That he finds it extremely difficult to cultivate the bacillus in the oyster. I think it has been done after the oyster has been subjected to treatment for three weeks and that sort of thing, but they do not increase in the oyster.

17074. (*Sir Michael Foster.*) But is there not evidence that it will remain in the oyster for at least 14 days?—If the oyster is kept under artificial conditions.

17075. What do you mean under artificial conditions—placed in sea water—is that an artificial condition? It is a question of multiplication. It is rather the time in which the bacillus might remain alive, and I think I am right in saying—you probably well know this from your observations as to how long after an oyster has been taken from a certain situation and known to contain bacillus within its interior either outside the pedial chamber or inside. It has been found that the bacillus may still be recognised in that fluid up to about

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14 days, and then after, say, ten or fourteen days, it can be no longer. That is distinguishing the oyster from the cockle, in which, evidently, there is evidence that the bacillus may be propagated?—Yes, that has never been tried under really natural conditions. You see when an oyster is kept in a tank of any sort it does not get the natural ebb and flow of the water.

17076. But the ebb and flow through the oyster is mainly effected by its own ciliary action?—That is quite right, but then there is the strong current passing over the oyster and if you notice an oyster when it is really on the bed where they are laying, when the tide begins to flow, you will see these oysters will open. When the tide ebbs they close again, so that they get a free current of water through them, but when they get into a tank they get nothing of that; it is an artificial condition entirely.

17077. If I remember aright these experiments were carried out with a continual flow through the tank to imitate as far as possible natural conditions?—Yes, but it could not do it because the water is deep which sometimes passes over the oyster, and very shallow at others It sometimes happens to be dry—it is very nearly impossible to get ordinarily in the laboratory an oyster in its natural condition.

17078. (*Mr. Stafford.*) Let us get away from the scientific aspect of the question altogether; let us come to the common-sense part of the business. I put you this case. Do you happen to know the estuary of the Liffey which is in Dublin?—I cannot speak about it from personal experience.

17079. Well, there are certain oyster layings in the estuary of the Liffey. Dublin is known to be probably one of the worst towns in the Kingdom for enteric fever. Do you think that it would be safe, from a common-sense point of view now, to have these layings in the estuary of the Liffey, not the æsthetic point of view now at all but the common-sense point of view of typhoid fever?—Well I am scarcely here as a Medical Officer of Health to give my opinion upon that question.

17080. No, but you volunteered a statement to commence with that in your opinion it was practically impossible to communicate enteric fever through oysters?—I think you are in error there · I did not volunteer the statement; I was asked; it was simply in answer to a question. I did not volunteer a statement.

17081. Well, you committed yourself to the opinion, may I say?—Yes.

17082. And I would like to get an acknowledgment from you that you might possibly be wrong?—Well, I do not think you would be able to get an acknowledgement from me that I am likely to be wrong over it. A great many people eat the oysters from the Liffey, do they not?

17083. Most of them in England?—But they eat them in Ireland too.

17084. They do, but the beds are owned by a Liverpool firm and they are eaten chiefly in England—the blue-point oyster?—How many oysters should you think would be sent from the Liffey?

17085. I could not commit myself to a number?—Well enough to feed some thousands of people.

17086. A good many oysters go to England?—You think there would be enough to feed some thousands of people.

17087. Well, that depends upon how much they would eat?—Well, I can say that there is enough to feed some thousands of people. Well we do not hear of thousands of people suffering from typhoid fever.

17088. But you do not hear of every person who happens to take bacillus into his system through drinking polluted water getting typhoid fever?—Then it is a question. I say we are obliged to believe they get it from water, because the doctors tell us so, but we might say we are obliged to believe it about the oysters, but we cannot believe that, for instance, as you say, there are some thousands—I do not know that you said there was some thousands—but there was a great quantity of oysters went from the Liffey to Liverpool, and I suppose most of them would be eaten in Liverpool or the surroundings, and yet there there are no fearful epidemics of typhoid fever there, and if we were to take all that the doctors say as infallible, we should have thousands of cases because thousands of people eat them.

17089. Then you think there is no danger to the public of getting enteric fever through eating the oysters which are laid in the estuary of the River Liffey, although Dublin is known to be a typhoid fever town?—The danger would be very remote, and I should take it very very remote, or we should hear of very many epidemics. Personally, I do not now think that it would be communicated from there or we should hear of it. As I said before the possibility of everything——

17090. With regard to the American oysters, do the State Departments give certificates of the purity of the estuary from which they come?—I am not sure whether the State Departments do.

17091. The State Health Departments, do they give certificates?—A great many bacteriological certificates are sent over with the oysters.

17092. With the oysters; but do the State Departments give these certificates, or the State Health Departments?—I am not quite sure about that, but I know that the States in some places in America, guarantee that they are free from pollution.

17093. I saw in one case recently, a State certificate to the effect that there was no pollution of the estuary in which these oysters were laid. I wanted to know whether that was a general thing with regard to American oysters?—Well I could not say that I have had personal experience of it being done in a great many cases, and I think there has been no difficulty in getting the States, where the oyster layings are, to give certificates. I do not think there would be any difficulty about that, because as I said before, I think they are just as particular as we are in England.

17094. Do you think it would be a wise thing to do? —Decidedly; a certificate of origin I think we may call it.

17095. (*Chairman.*) May I just ask you about this question whether you are aware that at least five places where the shellfish were stored were condemned by Dr. Bulstrode, in his report to the Local Government Board in 1894, and that five outbreaks of typhoid fever have subsequently occurred?—Yes, I am perfectly aware of that, but the question is whether those outbreaks of typhoid were caused by the oysters or not. For instance we will take Winchester. That I think is one of the places condemned by Dr. Bulstrode where those oysters came from, Emsworth. I do not know exactly how many people partook of those oysters, but I should think not more than 7 or 8 per cent.—5 per cent. one may say—of the people who ate these oysters had typhoid fever, so that is not conclusive evidence that the oysters caused it.

17096. And you think, perhaps, that the outbreak in these five places would be nothing more than a coincidence?—As regards oysters, decidedly, one has to take the sanitary conditions of the places themselves.

17097. (*Sir William Ramsay.*) Might I ask a question or two about the Chamber of Fisheries; I do not quite understand what it is? Is it a voluntary association?—A voluntary association.

17098. Of persons who are themselves engaged in the fishery, or are selling fish?—Yes.

17099. All kinds of fish?—All kinds of fish.

17100. Is it confined to any one part of England?—No, to the United Kingdom.

17101. Have you any compulsory powers over the persons who belong to that association, or is it simply moral suasion?—Moral suasion.

17102. Thank you?—At present there is no power over the oyster fisheries by anybody; I mean, until we get an Act of Parliament, nothing can stop people putting them on the market.

17103. (*Dr. Burn Russell.*) How far are the opinions which you have expressed, the collective opinions of this Chamber of Fisheries, or your own personal opinions?—I should say it was the general opinion. Perhaps I may have gone a little too far so far as foreign oysters are concerned; some of them might not agree with me as far as I have gone, but the opinions that I have given may be taken as the general opinions of the Chamber of Fisheries—of the members—oyster members.

17104. (*Sir Michael Foster.*) Your particular opinion as to the modes of typhoid fever being conveyed by the oysters is not shared by the whole of your Chamber?—I think I may say—I think I may say by the whole of them. I am here, of course, by the authority of the Chamber of Fisheries as representing them.

17105. (*Dr. Burn Russell.*) Has the subject been definitely discussed and any resolution come to?—As to the danger of infection or the pollution of the fisheries generally.

17106. As to the practical aspect of the general opinion in scientific circles upon your trade?—Oh, yes; since the first typhoid fever scare we have been discussing it, and the conclusion we have come to is that the sewage should be taken from these fisheries. We cannot make an oyster fishery. It is virtually impossible to do it. You may only move perhaps half a mile and yet you find the ground not at all suited for oysters. There are only certain places where the oysters will get fat. As a rule a breeding ground for oysters is not a fattening ground.

17107. Then the practical conclusion arrived at is a concession to a popular delusion not a scientific opinion?—That you cannot make a new oyster bed.

17108. The reason of your resolution to the effect that it was desirable to separate oysters from sewage pollution was a mere concession to a public delusion and not to a scientific opinion?—I scarcely follow you there.

17109. Well you do not believe in anything which is alleged as a reason by scientific men?—Oh, I believe in a great deal that is alleged by scientific men, but in this one point I cannot say that I follow them decidedly—I should be very sorry——

17110. I speak entirely on this, not on the general question?—Oh, you mean on this point.

17111. On this point?—Well as far as infection being carried by the oysters, I certainly cannot go with the scientific men but in other cases I can go with them and I quite believe in them but in this case I cannot.

17112. I am somewhat interested to clearly distinguish how far you speak for the trade, and how far for yourself simply for this reason, we have had so many gentlemen engaged in your trade, who admit with thorough conviction all that has been concluded by scientific observations?—They admit it?

17113. Yes?—Well, do you not think that perhaps, might have been caused by so many questions being asked them, and they being asked to give so many different answers by different people, that they might contradict themselves. Such things have been known, that they might admit things that really, if you had been talking to them either before the cross-examination or after they would not have admitted.

17114. That is your suggestion?—That is my suggestion that they might have done that.

17115. (*Colonel Harding.*) I should like to ascertain from you how far your Chamber of Fisheries is really representative of an important section of the trade. What does your Chamber consist of, representatives of fishing associations, or fish merchants, or what?—Fish merchants associations, in fact, I might say practically every branch of the fishery.

17116. How many members are there of your Chamber?—About 200.

17117. And does each of those members represent some fishing company?—Oh, no, each member, some of them are private members, some represent companies. I think I may say the Whitstable Oyster Company is the only company that is not represented in our Chamber of Fisheries in oysters.

17118. Are we to take it that the Chamber of Fisheries is representative of the fisheries of this country generally?—Yes, I think I may say so.

17119. You have representatives from different parts of the country?—Oh, yes.

17120. And representing most important associations of fisheries?—Yes.

17121. Well, I will not go over ground that has been gone over before, but we are to take it that although neither you yourself nor the majority of your members in the least believe in the possibility of infection from the eating of shellfish, you, nevertheless, are prepared to recommend that stringent action should be taken to compel local authorities to spend large sums of money to purify the sewage?—Yes.

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17122. Notwithstanding the view that you have told us?—For public health generally they should do it, I think.

17123. What do you mean by public health there, you tell us that the public health in your opinion cannot suffer. Then why should you, in the interests of the public health desire that these things should be done?—I do not think I have said that the public health could not suffer. I said I did not believe that oysters could communicate typhoid fever, but I think public health may suffer from sewage—crude sewage being poured on to the—virtually on to the beach—at some distance from the beach, but it is frequently washed up on to the beach itself. It cannot be healthy to have sewage under one's nose and be breathing it all day long; watering the streets with sewage polluted water, and all that sort of thing. That is what I mean by public health generally. As a rule sewage destroys an oyster fishery. If it comes in any quantity it kills the oysters; it prevents them breeding on the place.

17124. Have you evidence of that?—Oh yes.

17125. Evidence that the presence of sewage injures the constitution of the oyster?—Oyster fisheries, yes.

17126. (*Sir Michael Foster.*) That is where the sewage forms a sediment which clogs the branchia?—Yes.

17127. It is not the poisonous character of the sewage; there is no evidence that oysters suffer from eating sewage?—Well, you see some years ago there used to be a heavy fall of spat on the Southend foreshore. Well that is virtually a thing of the past now. There are just a few spat there very occasionally but that is only since the sewage has been discharged there in such large quantities.

17128. But for spat you require a bottom of peculiar quality do you not?—The bottom is there for it.

17129. Has not the bottom been altered from the sediment from the sewage. You want clean fragments of stone do you not for spatting; you throw down stones on purpose and so on?—Yes.

17130. And if that is quite covered over with sewage sediment that prevents spatting?—You cannot get it.

17131. But that is a different thing from injuring the oyster itself?—We have a very large percentage of deaths of the oysters on the shore when they are put there, when you get near a large sewage discharge. I have voluntarily closed my own beds at Southend some years ago now.

17132. (*Dr. Burn Russell.*) For the sake of the oyster?—The general idea of the public was that oysters were not good coming from polluted sources and one naturally thought that it was not worth while giving the public any reason to think that they come from these places so the bed was closed.

17133. I thought you said oysters were actually killed or seriously injured?—Seriously injured, yes. They have been very seriously injured, but since the sewage has been discharged in such huge quantities as it has been discharged we have not had anything much there to test in the shape of oysters.

17134. I think you said something about 5 per cent. of those who dined at Winchester and ate oysters had typhoid fever?—Not 5 per cent., I think.

17135. Not 5 per cent.?—Not 5 per cent., Yes. I cannot tell the exact figure now, but I do not think it was anything like 5 per cent. who had typhoid fever who had eaten oysters.

17136. Then would you be prepared to admit that half of that had typhoid fever?—No, decidedly not. You see some years ago at Stirling there was a similar outbreak.

17137. You spoke of 5 per cent., and spoke of it with indifference, and that is what I want to get at?—No, I did not speak of it with indifference, I think.

17138. Well not indifferent in so far as it affected your trade, but fully indifferent in so far as those who ate oysters?—No, most decidedly not; I think you are wrong there; I think perhaps you misunderstood me. What I said was, that not 5 per cent. of

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the people who had partaken of the oysters suffered from typhoid fever, which seemed to be rather—well it did not seem as if the oysters themselves could have caused it, because if only 5 per cent. of the people who had oysters supposed to be polluted with typhoid bacillus had typhoid fever surely it cannot have been the oysters that caused it.

17139. It has an effect upon your mind at any rate?—Yes. It is open to a very great deal of doubt to the man who has most faith, I think.

17140. Do not assume that please?—Do you consider it conclusive evidence that the oysters caused the typhoid fever then, not 5 per cent. of the persons who partook of them, having it?

17141. Well it is an universal law that there is a very small percentage happily of those who are exposed to anything of that sort are actually influenced?—Yes but it is more than 5 per cent.

17142. Is it not a serious penalty? In some epidemics you have some hundreds of people take it, but if it is 2 per cent. do you not think it is a serious consideration that at a banquet, where hundreds of people dine, 2 per cent. in a fortnight or three weeks should be brought to death's door—if not actually ushered through death's door—by reason of the infection from oysters?—If it were conclusive; but I think you will find that more than 5 per cent. of people who are exposed to infection of that sort will suffer from it. You see 5 per cent. is a very small number of people if they are exposed to dangerous infection. I think you can scarcely say positively that the oysters caused it. The oysters may be looked upon with a great amount of suspicion; therefore I should like to remove the suspicion.

17143. (*Col. Harding.*) I should just like to ask you one more question about your Chamber, notwithstanding the views which you have expressed—and I think you say your members agree with you—your Chamber approved of legislation which tended to restrict the sale of oysters from beds which were in the neighbourhood of sewage outfalls?—I think they would all support a Bill of that sort, if the owners of the fishery were compensated.

17144. (*Sir Michael Foster.*) Might I just ask one more question, just with reference to the close time. There is, of course, a close time for oysters. What is it? May, June and July, is it not?—Yes.

17145. I understand that applies only to native oysters; it does not apply to imported oysters. American oysters can be sold during the close time?—Yes.

17146. Also French?—Yes.

17147. And Portuguese?—And Portuguese.

17148. Is that limited to the oysters immediately on their arrival. I mean may you lay down for a period an American oyster in spite of that close season?—Oh yes, because one does not get American oysters now. I mean the arrivals or the importation of American oysters for the season is practically over, and the same with most foreign oysters. You see when the warm weather comes on they cannot travel, so that they are laid down about this time of the year and they are sold really all through the summer at seaside places, mostly.

17149. Is there any limit to their being laid down until they come under the British rates so to speak?—No, it has been tried several times I think the Fishmongers Company took it up and prosecuted, but they still go on happily.

17150. So that practically an oyster of foreign origin can be sold at any time?—Yes.

17151. (*Chairman.*) Can you tell me whether your Chamber could supply a statement of mussels, periwinkles, and cockles, imported into the country?—For how long a period.

17152. Well, say the last five years?—I do not know that we should be able to give it to you exactly, but I could give it to you approximately I think.

17153. You could?—I think I could do it myself; I mean I would not guarantee that my figures were correct.

17154. I imagine that you would hardly be able to form any idea what proportion the foreign supply was to the whole supply?—Of mussels?

17155. Mussels, cockles, and periwinkles?—Well, cockles for the last five years, I should think, would be a very small percentage, periwinkles would be much higher, and mussels very high—a great many mussels.

17156. You would know about the home supply; you would have more idea of it?—I could give you the figures. They would be only approximate; I would not guarantee that they would be correct now going back five years; of course I could give my supply.

17157. And could you distinguish at all between what was used for human food and what was used for bait?—The imported mussels?

17158. Yes, I mean some are used for bait, are they not?—Yes; but I mean that those that I could give you particulars of would be simply those used for human food. I do not think the quantity imported for bait would be very large. They would not come to London, anyhow and you see most of them come to London that are used for human food.

17159. (*Sir Michael Foster.*) Is there not a considerable sale of mussels on the East Coast for bait?—Those would be got on the East Coast.

17160. No, but imported mussels?—No, from Scotland.

17161. From Holland?—From Holland to Scotland.

17162. There is a very large sale of imported mussels on the East Coast for bait?—For Scotland, line fisheries yes, I could not say directly; but I might be able perhaps to get you from Holland at any rate for one year; I do not know that I could get it for five years—the quantity sent over for bait—but I could from Holland—the particulars of those sent over for last year for bait I dare say.

17163. (*Chairman.*) There is a large quantity of mussels come to Hull, is there not?—I could not say off-hand how many, but I should not think nearly so many as come to London.

17164. Well any statement on these matters that you can give us we shall be very grateful for?—I think you want mussels from Holland for bait, also those sent to Hull and to London. Those to Hull would be for consumption I suppose in the Midland counties, and the North perhaps. That is what I take it you would like—periwinkles and cockles. (*See* Statement at end of Mr Baxter's evidence.)

17165. Is there any other shellfish that comes from abroad, whelks, or anything of that sort?—No, no whelks come from abroad; they come from the English coast.

17166. We may take it mussels, periwinkles, and cockles?—They are the chief.

17167. No scallops; do they come from abroad?—Well, they come from the French coast—some distance from the French coast—but I mean they are brought in by English vessels; they are not sent from abroad, they are brought in by our English vessels.

17168. Thank you very much—we are very much obliged to you.

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APPENDIX to Mr. *G. H. Baxter's* Evidence.

WINKLES AND MUSSELS RECEIVED FROM HOLLAND DURING THE YEARS 1900, 1901, 1902.

1900.

Winkles received from Holland	-	Baxter and Son	- 863 tons	- Total in Market, 1,720 tons.
Mussels ,, ,, South Holland	-	,, ,,	- 1,495½ ,,	- ,, ,, 2,900 ,,
,, ,, ,, North ,,	-	,, ,,	- 54½ ,,	- ,, ,, 100 ,,

1901.

Winkles received from Holland	-	Baxter and Son	- 548½ tons	- Total in Market, 1,190 tons.
Mussels ,, ,, South Holland	-	,, ,,	- 1,176 ,,	- ,, ,, 2,300 ,,
,, ,, ,, North ,,	-	,, ,,	- 48 ,,	- ,, ,, 95 ,,

1902.

Winkles received from Holland	-	Baxter and Son	- 382¼ tons	- Total in Market, 760 tons.
Mussels ,, ,, South Holland	-	,, ,,	- 450 ,,	- ,, ,, 850 ,,
,, ,, ,, North ,,	-	,, ,,	- 47¼ ,,	- ,, ,, 90 ,,

Baxter and Son,
15 and 16 Billingsgate, E.C.

9 June 1903.

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WINKLES RECEIVED FROM HOLLAND, 1900.

1900.	Bags.	1900.	Bags.	1900.	Bags.
1 January - -	4	16 April - - -	195	4 October - -	65
5 ,, - -	11	17 ,, - - -	4	11 ,, - -	202
8 ,, - -	61	18 ,, - - -	72	15 ,, - -	117
11 ,, - -	175	19 ,, - - -	87	17 ,, - -	15
15 ,, - -	56	20 ,, - - -	3	19 ,, - -	237
18 ,, - -	266	23 ,, - - -	86	22 ,, - -	22
22 ,, -	63	25 ,, - - -	152	25 ,, - -	206
25 ,, - -	166	27 ,, - - -	7	29 ,, - -	23
29 ,, - -	277	30 ,, - - -	6	29 ,, - -	17
2 February - -	286	2 May - - -	72	31 ,, - -	11
2 ,, - -	217	4 ,, - - -	17	1 November - -	116
5 ,, - -	112	7 ,, - - -	16	2 ,, - -	137
9 ,, - -	163	9 ,, - - -	115	5 ,, - -	71
9 ,, - -	9	11 ,, - - -	13	9 ,, - -	184
15 ,, - -	191	14 ,, - - -	8	10 ,, - -	15
22 ,, - -	218	16 ,, - - -	4	12 ,, - -	32
26 ,, - -	277	17 ,, - - -	22	14 ,, - -	6
28 ,, - -	9	18 ,, - - -	4	16 ,, - -	379
2 March - - -	314	21 ,, - - -	4	20 ,, - -	5
2 ,, - - -	239	25 ,, - - -	15	21 ,, - -	10
5 ,, - - -	230	28 ,, - - -	7	22 ,, - -	301
8 ,, - - -	365	1 June - - -	6	26 ,, - -	49
12 ,, - -	11	5 ,, - - -	6	29 ,, - -	229
13 ,, - - -	174	6 ,, - - -	24	5 December - -	116
16 ,, - - -	173	8 ,, - - -	3	7 ,, - -	243
20 ,, - - -	26	11 ,, - - -	7	10 ,, - -	60
23 ,, - - -	11	15 ,, - -	7	12 ,, - -	111
23 ,,	70	18 ,, - - -	5	14 ,, - -	250
27 ,, - - -	30	25 ,, - - -	4	15 ,, - -	2
29 ,, - - -	52	31 ,, - - -	4	19 ,, - -	167
31 ,, - - -	5	3 August - -	9	21 ,, - -	108
2 April - - -	38	6 ,, - -	2	22 ,, - -	3
4 ,, - - -	83	10 ,, - -	4	25 ,, - -	43
4 ,, - - -	27	14 September - -	26	28 ,, - -	236
5 ,, - - -	173	17 ,, - -	16	31 ,, - -	100
9 ,, - - -	52	21 ,, - -	32		
11 ,, - - -	90	24 ,, - -	24		9,863
11 ,, - - -	2	28 ,, - -	55		Which equals 863 tons.
12 ,, - - -	96	1 October - -	10		

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WINKLES RECEIVED FROM HOLLAND, 1901.

1901.	Bags.	1901.	Bags.	1901.	Bags.
4 January - -	111	18 April - - - -	306	21 October - - -	10
7 ,, - -	62	22 ,, - - - -	5	23 ,, - -	7
14 ,, - -	1	23 ,, - - - -	6	26 ,, - -	383
25 ,, - -	6	25 ,, - - - -	322	28 ,, - -	38
31 ,, - -	116	29 ,, - - - -	5	1 November - -	234
1 February - -	246	1 May - - -	132	2 ,, - -	2
4 ,, - -	37	3 ,, - - -	2	4 ,, - -	2
6 ,, - -	13	7 ,, - - -	5	8 ,, - -	187
9 ,, - -	186	10 ,, - - -	3	11 ,, - -	2
11 ,, - -	55	13 ,, - - -	1	13 ,, - -	3
13 ,, - -	9	20 ,, - - -	1	15 ,, - -	247
14 ,, - -	126	23 ,, - - -	5	18 ,, - -	126
16 ,, - -	9	7 June - - -	5	18 ,, - -	7
18 ,, - -	34	10 ,, - - -	8	22 ,, - -	152
21 ,, - -	33	14 ,, - - -	7	25 ,, - -	51
22 ,, - -	45	14 ,, - - -	4	28 ,, - -	315
23 ,, - -	7	24 ,, - - -	3	2 December - -	3
27 ,, - -	3	5 July - - -	2	4 ,, - -	11
28 ,, - -	92	29 ,, - - -	2	5 ,, - -	19
2 March - - -	22	26 August - -	4	7 ,, - -	258
4 ,, - - -	2	9 September - -	2	9 ,, - -	19
5 ,, - - -	178	10 ,, - -	7	13 ,, - -	95
6 ,, - - -	6	20 ,, - -	13	16 ,, - -	79
7 ,, - - -	127	23 ,, - -	11	19 ,, - -	88
13 ,, - - -	53	27 ,, - -	28	20 ,, - -	73
15 ,, - - -	279	30 ,, - -	9	21 ,, - -	2
18 ,, - - -	15	4 October - -	32	23 ,, - -	3
21 ,, - - -	74	7 ,, - -	8	24 ,, - -	23
27 ,, - - -	4	10 ,, - -	2	27 ,, - -	15
28 ,, - - -	67	11 ,, - -	60	30 ,, - -	6
1 April - - -	63	16 ,, - -	2	30 ,, - -	2
5 ,, - - -	225	18 ,, - -	17		6.209
7 ,, - - -	75	19 ,, - -	3		Which equals 548½ tons.
11 ,, - - -	276				
15 ,, - - -	68				

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WINKLES RECEIVED FROM HOLLAND, 1902.

1902.	Bags.	1902.	Bags.	1902.	Bags.
1 January	9	27 March	154	1 September	3
3 "	141	28 "	3	29 "	2
4 "	3	31 "	63		
6 "	6			3 October	11
6 "	48	4 April	17	4 "	1
9 "	195	11 "	86	6 "	6
10 "	2	14 "	30	10 "	14
11 "	12	18 "	99	14 "	1
11 "	7	19 "	2	16 "	4
13 "	66	21 "	7	17 "	14
14 "	29	24 "	95	18 "	2
16 "	76	28 "	20	24 "	32
17 "	254			31 "	3
20 "	106	2 May	4		
22 "	7	5 "	2	1 November	104
23 "	258	8 "	2	3 "	71
24 "	4	12 "	3	6 "	2
27 "	7	16 "	11	7 "	192
28 "	57	20 "	6	10 "	52
31 "	72	22 "	4	12 "	40
		26 "	1	14 "	144
1 February	23	30 "	6	15 "	3
3 "	25			21 "	80
6 "	79	2 June	3	24 "	23
10 "	34	5 "	18	26 "	17
12 "	15	9 "	3	27 "	42
14 "	55	16 "	6	28 "	5
15 "	8	20 "	10	29 "	37
17 "	16	21 "	6		
20 "	73	30 "	8		
				5 December	9
3 March	9	4 July	11	20 "	10
4 "	23	7 "	5	23 "	10
8 "	35	11 "	2	26 "	40
10 "	15	18 "	8	29 "	2
10 "	43	21 "	6	30 "	111
13 "	284	26 "	24		4,367
17 "	43	28 "	4		
21 "	366				
24 "	42	8 August	4		Which equals 382¼ tons.

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SOUTH DUTCH MUSSELS RECEIVED DURING 1900, 1901 and 1902.

1900.		1901.		1902.	
Week ending	Bags.	Week ending	Bags.	Week ending	Bags.
5 January - - -	284	5 January - -	391	3 January - -	197
12 ,, - - -	406	12 ,, - -	274	10 ,, - -	80
19 ,, - - -	373	19 ,, - -	114	18 ,, - -	170
26 ,, - - -	372	26 ,, - -	260	25 ,, - -	136
2 February - -	409	2 February - -	227	1 February - -	210
8 ,, - -	327	9 ,, - -	341	8 ,, - -	105
15 ,, - -	182	16 ,, - -	305	15 ,, - -	108
22 ,, - -	170	23 ,, - -	104	22 ,, - -	90
2 March - - -	289	2 March - - -	240	1 March - - -	129
9 ,, - - -	310	9 ,, - - -	273	8 ,, - - -	80
16 ,, - - -	255	16 ,, - - -	269	15 ,, - - -	67
23 ,, - - -	120	23 ,, - - -	258	22 ,, - - -	61
30 ,, - - -	200	30 ,, - - -	246	29 ,, - - -	119
6 April - - -	200	6 April - - -	101	5 April - - -	25
13 ,, - - -	115	13 ,, - - -	46	12 ,, - - -	—
20 ,, - - -	60	20 ,, - - -	25	19 ,, - - -	—
7 July - - -	20	7 July - - -	—	7 July - - -	—
14 ,, - - -	147	14 ,, - - -	20	12 ,, - - -	—
20 ,, - - -	186	20 ,, - - -	161	19 ,, - - -	40
28 ,, - - -	220	27 ,, - - -	225	26 ,, - - -	40
4 August - - -	265	3 August - -	340	2 August - -	155
10 ,, - - -	443	10 ,, - -	486	9 ,, - -	321
18 ,, - - -	705	17 ,, - -	670	16 ,, - -	450
25 ,, - - -	713	24 ,, - -	711	23 ,, - -	340
		31 ,, - -	657	30 ,, - -	180
1 September - -	760				
8 ,, - -	814	7 September - -	671	6 September - -	173
15 ,, - -	851	16 ,, - -	662	13 ,, - -	136
22 ,, - -	783	21 ,, - -	643	20 ,, - -	105
29 ,, - -	732	28 ,, - -	644	27 ,, - -	129
6 October - - -	744	4 October - -	622	4 October - -	130
13 ,, - - -	737	12 ,, - -	485	11 ,, - -	168
20 ,, - - -	613	19 ,, - -	508	18 ,, - -	169
27 ,, - - -	460	26 ,, - -	452	25 ,, - -	162
3 November - -	522	2 November - -	375	1 November - -	145
10 ,, - -	507	9 ,, - -	280	8 ,, - -	124
17 ,, - -	488	16 ,, - -	268	15 ,, - -	129
24 ,, - -	474	23 ,, - -	209	22 ,, - -	118
30 ,, - -	490	30 ,, - -	231	29 ,, - -	78
8 December - -	460	7 December - -	316	6 December - -	89
15 ,, - -	437	16 ,, - -	93	13 ,, - -	66
22 ,, - -	288	21 ,, - -	172	20 ,, - -	38
29 ,, - -	160	28 ,, - -	65	27 ,, - -	37
	17,091		13,440		5,099
	Which equals 1,495½ tons.		Which equals 1,176 tons.		Which equals 450 tons.

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NORTH DUTCH MUSSELS RECEIVED DURING 1900, 1901 and 1902.

1900.		1901.		1902.	
Week ending	Bags.	Week ending	Bags.	Week ending	Bags.
12 January	61	5 January	10	4 January	86
16 "	17	26 "	40	15 "	46
24 "	50	25 February	2	24 "	125
9 February	38	9 March	20	25 "	41
16 "	75	16 "	54	1 February	50
24 "	9	23 "	10	15 "	22
12 March	91	6 April	10	22 "	59
11 April	57	27 "	10	1 March	15
18 "	36	4 May	47	8 "	25
23 "	20	10 "	55	15 "	43
7 May	15	28 September	10	22 "	62
15 September	20	12 October	10	29 "	20
22 "	23	26 "	30	5 April	16
29 "	20	2 November	82	19 "	33
6 October	35	9 "	54	28 "	40
13 "	40	16 "	105	3 May	32
20 "	41	23 "	3	25 "	30
27 "	15	30 "	28		
3 November	17	7 December	58		
1 December	61	16 "	68		
8 "	35	28 "	53		
15 "	61				
22 "	30				
	867		759		745
	Which equals 54½ tons.		Which equals 48 tons.		Which equals 47¼ tons.

Dr. J. T. C. Nash, called; and Examined.

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17169. (*Chairman.*) You are Dr. Nash, the Medical Officer of Health for Southend-on-Sea?—I am, my Lord.

17170. To what extent do you consider that enteric fever or other illness is caused by the consumption of sewage contaminated shell fish?—My researches into the causation of typhoid fever have led me to believe and declare that a very considerable proportion of the residuum of typhoid fever in this country which persists in spite of all sanitary efforts and circumstances, is due to the consumption of infected shell fish from sewage contaminated sources. Out of 105 cases of typhoid fever notified in Southend during 1902, I traced some connection with shell fish in at least 82 cases. Besides the definite cases of typhoid fever, I know of several other persons who had diarrhœa after eating cockles from the Leigh Creek, into which the Leigh sewage effluent discharges. At Brighton 30 per cent. of the cases of typhoid fever which occur are attributed to infected shell fish. At Yarmouth typhoid fever was unduly prevalent in 1898 and 1899. These cases were attributed by the Medical Officer of Health (Dr. Russell) to the consumption of mussels taken from the Yare. The sale of these was stopped in 1900, and forthwith a marked diminution of typhoid fever in Yarmouth was observed, to such a degree indeed, that the largest number of notifications in any one month in 1902 was 30 per cent. below the average monthly mean for the preceding years. In my own district, by repeatedly drawing attention to sewage contaminated shell fish as a cause of typhoid fever, and thereby securing less consumption on the one hand, and better methods of laying and cooking, and greater care in the procuring of shell fish from purer layings, on the other hand, I think I have secured a decided diminution in the incidence of typhoid fever. At any rate, the Borough of Southend has been practically free of typhoid fever since January last. I wish to lay particular stress on the following:—During 1902 I made special inquiries, as far as possible, as to what proportion the shell fish eating section of the community bore to the entire population, and as to the relative incidence of typhoid fever on these two sections of the population, and also on shell fish vendors as a class. I had inquiries made at 656 houses where cases of small-pox, scarlet fever, diphtheria, chicken pox, and typhoid fever had been notified in different parts of the borough. As a result, I ascertained that with only two exceptions the only shell fish eaters in this inquiry were found in 69 houses where typhoid fever had occurred. If the typhoid cases be omitted, only two houses out of 587 admitted shell fish. Another important fact in arriving at a relative estimate is this: 20 out of 22 shell fish shops in the Borough of Southend, close in October until the following season, because there is so little local trade in shell fish. If 5 per cent. of the population are shell fish eaters there should be at least 1,500 persons in the borough who eat shell fish; but I gather from the two or three local shell fish merchants who keep their shops open in the winter that their local custom is with only about 50 houses. Allowing, as a liberal calculation, that five persons in each house consume shell fish, this would give a total number of only about 250 persons as shell fish eaters out of a population of about 32,000. No doubt in the summer, when several shell fish stalls are open, a larger proportion eat shell fish, particularly so-called "boiled" cockles. An estimate of 1,600 persons, or 5 per cent. of the total population, cannot be considered an underestimation, in face of the facts I have narrated, and probably is more than double the actual number. Still, to allow a wide margin, I base my figures on 5 per cent. of the population as shell fish eaters, and 95 per cent. as non-shell fish eaters. The standard terms of the ratios during 1902 per 1,000 persons in each section of the population are calculated as follows:—For the entire population the attack rate was 3·28 per 1,000 persons. For the shell fish eating (reckoned at 5 per cent. of the total population) 51·25 per 1,000 persons. For the remainder of the population 0·54 per 1,000 persons. The enormous preponderance on the shell fish eating section is rendered very obvious by these figures (cæteris paribus).—Even if a larger proportion of the population were reckoned to be shell fish eaters, it is obvious that the preponderance of typhoid fever on the shell fish eaters is enormous, other things being equal.

17171. (*Sir William Ramsay.*) This refers to the population of Southend during the winter, not the summer fluctuating population?—The summer population is a fluctuating population.

17172. So I suppose you are taking the figures from the winter?—The residential population, and I may say that the cases of typhoid fever which occurred were all among residents.

17173. (*Sir Michael Foster.*) You do not think that the people in Southend who have any objection to the local shell fish would have shell fish from elsewhere, because only fifty houses in Southend apparently eat shell fish from their local customers; do you think that excludes, I mean——?—Their having them from elsewhere.

17174. Yes, they would say, "I do not like the Southend shell fish; I will have my oysters from London"?—The question was merely asked as to shell fish, not where they got them from, but whether they ate shell fish, any form of shell fish; the question was not "Do you eat"——

17175. Have you polled them? I did not understand from this as to whether you polled them, as to whether they ate shell fish?—Yes, I had inquiries made in every case of infectious disease.

17176. But only in those cases of infectious disease?—Only in those cases of infectious disease.

17177. Because in regard to the eating of shell fish in the winter, you deduced that from the supply, from the local shops?—No doubt there would be some among those who come to London who probably would eat shell fish in London.

17178. And bring it home?—And perhaps bring it home, but I doubt whether they bring it home. I can, of course, not give exact figures in those matters.

17179. You do not think that that is a factor worth considering?—I think it is a factor worth considering. I do not think it would make very much difference to the results. It is easier to more exactly estimate the numbers of shell fish vendors, and their employees, and I calculated the attack rate for these as a class at no less than 160·0 per 1,000 persons. I think I have adduced sufficient evidence to justify me in stating that typhoid fever is to a very large extent caused by the consumption of sewage contaminated shell fish. I may lay stress on another point. The seasonal incidence of typhoid fever in this country generally is at its lowest in May and June. This is concurrent with the close season for English and French oysters, and with the period when cockles and mussels are not in their prime, and are less eaten than at other times. A point worth bearing in mind is that the chief seasonal incidence of typhoid fever in London occurs at a later date (November and December), than in the rest of the country generally. I am inclined to attribute this in great measure to the fact that shell fish are largely eaten in the country generally, chiefly in the autumn, while in London shell fish are still largely consumed in the early winter months. A notable exception is Brighton, which has a winter as well as a summer season.

17180. (*Chairman.*) I should just like to ask you what better method of laying you succeeded in introducing? You say you secured less consumption and a better method of cooking?—The local shell fish merchants now obtain their shell fish from Whitstable instead of from the Leigh Creek; they bring them over and do not lay them in sea water at all; they put them to clean in the Southend Waterworks Company's water, and boil them in that water, so that they are not laid at all anywhere in the neighbourhood; not in sea water.

17181. (*Sir Michael Foster.*) Is there a close season for the French oysters; I thought the close season was limited to English oysters?—I understand it is both French and English, but Dr. Bulstrode can correct me on that point.

17182. The American and Portuguese oysters?—They are still in season; they are sold all the year round, I believe.

17183. So that there might be as large a consumption of oysters in the summer as in the winter?—I doubt whether it is as large; naturally our home oysters——

17184. But it would rather modify the force of your deduction, will it not?—Certainly. I merely bring that forward as a point, but I do not claim for it anything more than the point that for our home oysters we have a close season.

17185. Mr. Baxter, who has just given us evidence, has said that it does not apply at all to the foreign

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oyster the close season, not even to the foreign oyster which for a while has been laid down in an English laying?—I believe not for American oysters at all—blue points, and so on; I believe they are sold all the year round, and, perhaps, Portuguese oysters also, but I understand that for French as well as English oysters a close season does apply.

17186. He said French oysters could be sold also during the close season; he is a large oyster merchant?—I was not aware of that; I was informed otherwise.

17187. (*Chairman.*) What measures do you think should be adopted for preventing any danger to the public health. Does not 5 per cent. seem a very small proportion of shell fish eaters if one goes on one's own experience?—One finds that in a seaside borough it is generally the newcomers who eat shell fish. They soon seem to learn by experience that there is danger in them, and the older residents, as a rule, do not eat shell fish. I thought I gave every member of the Commission a special report on the outbreak of typhoid fever in Southend during June and July, 1902, which I made some time back. There was a diagram in that which might be of assistance in estimating the proportion. It is used to estimate the proportion of 25 per cent. population as compared with 75 per cent. If one took those as the proportions the notifications rate per thousand persons among 25 per cent. would be represented by that length, while amongst 75 per cent. the notifications would be represented by that length; that is to say, that corresponds to that, and this to that, but if you take 5 per cent., which, I think, is the nearer figure, this corresponds with that and that with that (*indicating on diagram*).

17188. Yes, I see that; that is very ingenious?—In answer to your question, my Lord, I suggest that legislation is required on the following lines to provide for (1) penalties for cultivating or laying down shell fish in narrow creeks which receive either crude sewage or sewage effluents, unless such effluent has passed through land in addition to contact beds, and satisfies a bacterial standard of purification. In the presence of Dr. Houston and others I do not want to push this point, as you can get expert information on the matter. (2) Penalties for the pollution of layings and cultivation beds, which at the present time are pure. (3) Registration, efficient supervision, and inspection of all shell fish layings. (4) Powers for sanitary authorities to prohibit the sale of such shell fish within their districts, as, in the opinion of the Medical Officer of Health, were causing disease. (5) Clauses to deal with imported shell fish. Further, I would suggest that it be authoritatively stated and required that such shell fish as cockles and mussels shall be subjected to a heat of 80° C. for a period of 15 minutes at the least before they are exposed for sale for consumption. In my opinion it should be illegal to expose shell fish for sale unless they are from layings which are either entirely above suspicion or, at any rate, are a considerable distance (at least a mile) from any obvious source of pollution, and covered with sea water at all states of the tide. I am inclined to go even further and say that, as with a public water supply, so also with all kinds of public food supplies (including shell fish), it ought to be an absolute condition that these should be incontaminable by drainage. It is my opinion that if the sale of shell fish from any layings open to even the slightest suspicion of sewage pollution were prohibited unless cooked in such a manner as to secure that every part shall be exposed to a temperature of 70° to 80° C. for at least 15 minutes, we should go a long way towards solving the greater part of the problem of the residual typhoid in this country, which is untouched by the present achievements of sanitary science. A proper control of shell fish will, I think, secure a notable reduction in the seasonal incidence of typhoid fever, and a moderate reduction in that of diarrhœal diseases generally.

17189. Do you see that there would be any difficulty in enforcing restrictions on the shell fish industry?—There is bound to be some opposition until the shell fish merchants recognise that it is in their own interests to take every possible care to obtain their shell fish from the purest possible layings. As a public health officer I consider it my duty to continue to warn the public against eating shell fish from sewage contaminated sources. In my own district the majority of the local shell fish merchants have realised the importance of taking every possible precaution. They now obtain their cockles from Whitstable (from a spot well removed from obvious pollution) instead of from the Leigh Creek at a spot just below the Leigh sewage outfall as formerly; put them to clean in pure fresh water supplied by the Southend Water Company, and then boil them for at least 3½ minutes in pure water. If all cockle vendors will take the same precautions, I venture to think that this particular form of shell fish may be safely eaten, and that the cockle industry, if intelligently and carefully managed under proper sanitary supervision, may yet flourish and cease to be a danger to the public health. With respect to oysters, however, the conditions as to cultivation, laying, and supervision should be yet more stringent and exacting, because this form of shell fish is generally eaten raw. As regards this form of shell fish, therefore, it is my opinion that all the conditions should be above suspicion. I have noticed that, generally speaking, the type of typhoid fever following the ingestion of parboiled cockles is milder than that observed where raw shell fish are eaten. The inference is that the partial cooking of the cockles has diminished the numbers and attenuated the virulence of the contained pathogenic bacteria of typhoid. On the other hand, Dr. Elliston, of Ipswich, has observed a severe type of typhoid fever following the ingestion of raw cockles from the Orwell. This would be in accordance with Dr. Klein's observation that typhoid bacilli actually multiply within the cockle, even though the cockles may be put to clean for three days in clean salt water. The importance of these observations cannot be over-estimated nor those of Professors Klein, Boyce, and Hewlett, that the oyster naturally does not contain B. Coli or B. Enteriditis sporogenes, and that, therefore, the presence of these organisms in any shell fish is strong evidence of pollution by sewage or a sewage effluent.

17190. You speak of layings being at least a mile from any obvious source of pollution; have you any particular reason for saying one mile?—No, my Lord, not further than that it should be well removed from pollution.

17191. (*Sir Michael Foster.*) Have you formed any opinion about the cases of diarrhœa, and so on, that sometimes apparently are caused by eating shell fish; as to the nature of the malady?—I have not been able to inquire very fully into this, but I noticed that in one or two houses where typhoid fever was notified I learned that previously two or three persons in that house had suffered from diarrhœa shortly after eating shell fish at the same time that the shell fish were eaten, which apparently were the cause of the typhoid fever in the notified cases, but I did not learn of this diarrhœa until some days later, naturally when the persons who had had the diarrhœa had recovered.

17192. How would you regard the diarrhœa—as due to some other organism?—As possibly due to the typhoid organism.

17193. We have reason to think then, have we, that the typhoid organism may simply give rise to diarrhœa?—I think so.

17194. There is evidence to that effect, is there?—As I think there is, sir; I think we have such evidence, and we know that there are mild cases of typhoid fever.

17195. Typhoid fever, because of the bacillus typhoidus?—I think so. I have a case in mind which I viewed with very strong suspicion. It looked simply a case of diarrhœa. The gentleman affected did not lie up, and would not consent to have his blood taken for the Widal re-action. I had a strong suspicion that he had had typhoid fever. A secondary case occurred in the house following upon his illness.

17196. You have met with other cases?—I have met with other cases besides that. I refer to one or two in the special report. I wrote in my monthly report to the Health Committee of the Southend Town Council on the 30th June, 1902:—"A large majority of the cases of typhoid fever had eaten cockles round about the 31st May, and in nearly every one of these cases the cockles were said to have come from a neighbouring district. In two families, other members of the family partaking of cockles at the same time had 'fortunately' suffered from diarrhœ soon after. I say 'fortunately' because this additional evidence points strongly in two directions: (1) That the cockles consumed were unwholesome, and rendered several people ill; (2) that the diarrhœa was a fortunate result for those who were affected, because by natural means the specific germ of typhoid fever was probably rapidly eliminated from the body. In two instances, the only person in a family (where all had partaken of cockles) who was thus not affected at the time subsequently developed typhoid fever." I think that is a most important point. Several members had partaken of the cockles, most of them suffered immediately from diarrhœa, two did not, and those two subsequently developed typhoid fever.

17197. Is there any evidence of the oyster or other shell fish conveying an organism simply giving rise to diarrhœa, any specific organism?—I have not worked out that point.

17198. You approve of the cockles being brought from Whitstable?—I consider they are very much less dangerous from that source than from the Leigh Creek.

17199. Would they come up to your standard, do you think—your bacterial standard at Whitstable?—I have not examined them personally.

17200. No; but these are boiled afterwards?—These are boiled afterwards, and boiled for a longer period than previously, and boiled in pure water.

17201. I see you recommend in No. 3, "registration"?—Yes, sir.

17202. That is to say that certain layings or certain pits and so on, would be registered as free from contamination?—No, my meaning was that they should be registered so that they might be duly supervised and inspected.

17203. I see; that there should be simply a registration of the oyster layings and pits?—That is what I mean, just as we register dairies.

17204. Have you considered the possibility that after an adequate examination of the layings and pits they might be registered as free from contamination?—I have considered that; I should think that that would be a very good thing indeed.

17205. And do you think it is practicable?—It would be very difficult. I should not very much care to do it on my own researches, but if they were certified as free by a competent bacteriologist I should.

17206. Well, naturally such registration would only be effected I imagine by the agency of some possibly central authority?—Quite so.

17207. At all events by some large important authority fully equipped?—Fully equipped, yes.

17208. Fully equipped with the means of arriving at a judgment?—That would be what I should think.

17209. If such an authority were established and layings and pits approved by them were registered as free from contamination that would be, to a large extent, a solution of the whole matter, would it not?—I should think so, sir. I should be perfectly satisfied with that method of dealing as far as my own district is concerned.

17210. Of course the registered layings and pits would always be under supervision?—Quite so.

17211. That would continue even after registration?—Yes.

17212. And the registration might be for a limited period?—Yes, I should quite agree to that; I should think that would practically be the solution of the whole difficulty, such efficient registration and supervision.

17213. That would apply very well to oysters, would it not; it would be very difficult, would it not, for mussels, and especially for cockles, which are sporadic in their distribution?—Yes, certainly.

17214. I mean this; you could trace the oysters very easily; you could ascertain that the oysters came from such and such a registered laying; but with regard to the cockles and mussels—especially cockles—there would be greater difficulty, would there not?—Well, if they were a long way removed from any obvious sources of pollution the methods of cooking to which they were subjected would probably meet the case.

17215. Do you think it would be practicable legally to insist upon adequate cooking; do you think that that could be actually carried out?—I cannot state from a legal point of view at all, but I find that the local shell fish merchants are very anxious to meet the sanitary authority on this matter.

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17216. But you seem to suggest, do you not, that it should be compulsory that cockles should be cooked and adequately cooked, and that applies to mussels, too, because mussels are very often eaten cooked, or generally eaten cooked?—Generally; but they are often eaten raw.

17217. At present both the cockles and the mussels are very imperfectly cooked for sale?—They are, particularly the cockles.

17218. But, apparently, you see no difficulty in insisting legally that they should be properly cooked. It would require very considerable and careful inspection, would it not?—It would so. Of course one would have to leave it largely to the shell fish merchants, with just occasional inspection. I have merely suggested that it might be authoritatively stated that they should be subjected to this heat; I do not suggest that there should be legislation on the matter.

17219. I beg your pardon; then my remarks were unnecessary. It was simply a general recommendation that mussels and cockles should be cooked?—That was all. If you refer to the page you will see it follows the five clauses I have suggested.

17220. Then how would you deal with the imported shell fish; you show five clauses to deal with imported shell fish?—Merely to have the same examination of the shell fish when they arrive, and then the registration and the supervision of the layings, because the imported shell fish, I think, are almost invariably oysters; we do not get many other varieties, do we?

17221-2. Mussels are imported largely from Holland. Yes, and periwinkles?—We do not get many of those at Southend, so I am not well acquainted with them.

17223. All these regulations with regard to oysters I suppose would be under the Local Government Board?—I should think the Local Government Board would be the best authority.

17224. You do not see any reason why any of the Fishery Committees or the Fishery Board should intervene in the matter?—That is a difficult question. I think the Local Government Board is the best authority for that subject, but whether they could do it in consultation or together with the Fishery Board is a matter, I think, for consideration.

17225. You feel that the Fishery Board or the Fishery Committees ought to have something to say in the matter; may I interpret what you said just now in that sense? The interests of the fisheries are very largely involved, are they not?—They are so, and I think they ought to be consulted in the matter.

17226. That is to say, it should not be left entirely to the Local Government Board?—I think not entirely.

17227. That the Fishery Board or the Fishery Committee should have, so to speak, some *locus standi*; is that your idea?—I think in the primary discussions on the subject that they should certainly.

17228. But with regard to the authority?—With regard to the authority I should think the Local Government Board ought to have that alone.

17229. Alone?—Alone.

17230. And that the Fishery Committees or the other fishery authorities should simply have the opportunity of making representations in the discussions previous to legislation?—Quite so; or of appealing to even a higher authority in the case of their objecting to the action of the Local Government Board.

17231. (*Chairman.*) Appealing to a higher authority—do you mean the Courts of Law?—Quite so in cases, perhaps, in the same way that the appeals are made against judgments in other senses.

17232. But you would wish really the Local Government Board to be practically the managing authority?—I should, my Lord.

17233. (*Sir William Ramsay.*) Have you any difficulty in getting the dealers in fish—shell fish in Southend—to follow your advice; do they want much pressure?—At first they ridiculed the idea, naturally; they had independent examinations made, and they

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came to the conclusion that the matter was correct that the shell fish were contaminated which came from Leigh, and now they are taking precautions on the lines I have indicated.

17234. Do you happen to know whether any of them belong to the Chamber of Fisheries?—I do not know.

17235. Because we have just had evidence from that Chamber, which is said to represent the opinion of the Chamber, that any precautions are needless except from the æsthetic point of view?—No, I can speak for the leading shell fish merchants in the borough itself, and I can say that they are taking these precautions, and directly they have all their apparatus ready they will invite me down to inspect the same.

17236. (*Major-General Carey.*) Have Whitstable oysters been brought into Southend for consumption as well as cockles?—Yes; oh, yes.

17237. The oysters of Southend proper are still eaten?—No, we have no layings in Southend.

17238. Or near Southend?—No; the layings there have not been used for some years.

17239. Have you made any calculation as to the imported oysters which are eaten during the summer by the visitors at Southend?—No, I have not. I have no figures that I could give you.

17240. (*Mr. Stafford.*) How long have you been Medical Officer of Health of Southend, Dr. Nash?—For two years about.

17241. In reply to the first question, you say that your "researches into the causation of typhoid have led you to believe and declare that a very considerable proportion of the residuum of typhoid in this country, which persists in spite of all sanitary efforts and circumstances is due to the consumption of infected shell fish from sewage contaminated sources." What do you mean quite by the residuum?—Typhoid fever was, of course, a great deal more prevalent in this country many years ago. As the result of good drainage and pure water supplies the incidence of typhoid fever has very largely diminished. We now seem to have touched a level where we are not getting any further improvement for the last few years, and there still remains a certain amount of typhoid fever which is untouched by those sanitary measures of good drainage, a good water supply, and so on.

17242. Have you formed any idea of what proportion of the residuum is due to shell fish?—No, I have not any definite proportion, but I consider a considerable proportion is due to that, and I have instanced the town of Yarmouth, where until the sale of mussels from the Yare was stopped they had a considerable amount of typhoid fever, and yet when the sale of mussels from the Yare was stopped these instances of typhoid immediately fell in a most remarkable degree, so that in 1902 in September—the month of greatest incidence—it was 30 per cent. below the monthly mean of previous years.

17243. But is that conclusive, do you think?—It is only one out of many considerations.

17244. I mean to say, comparing one year with another year instead of a series of years, do you think that is quite a fair comparison? In typhoid fever we know there is the seasonal incidence of it?—Quite so.

17245. We know that there are certain years in which typhoid fever is very prevalent, it is epidemic, and for years afterwards it lies apparently in abeyance. Is it fair, therefore, to compare and say its reduction in 1901 is due altogether to the stopping of the sale of shell fish in 1900?—You see I am taking a series of years previous to that.

17246. In Yarmouth the sale was stopped in 1900, and then you had a 30 per cent. reduction in 1901?—Yes, there was almost as great a reduction almost directly after the sale was stopped, you see.*

STATEMENT handed in by Dr. *Nash*.

Great Yarmouth Monthly incidence of Typhoid for years 1897–1902.

	* 1897.	* 1898.	* 1899.	* 1900.	1901.	1902.	Totals for 6 years.	Average.
Jan. -	16	25	40	5	3	3	92	15·33
Feb. -	17	38	25	5	5	5	95	15·66
Mar. -	11	32	3	2	15	3	66	11·00
April -	2	17	3	2	20	1	45	7·5
May -	7	16	3	5	5	1	37	6·13
June -	3	7	4	3	4	0	21	3·5
July -	5	8	2	2	4	4	25	4·13
Aug. -	15	9	6	9	3	6	48	8·00
Sept. -	10	13	25	10	10	7	75	12·50
Oct. -	15	26	7	52	12	3	115	19·13
Nov. -	15	28	4	23	4	3	77	12·83
Dec. -	15	25	10	5	2	2	59	9·33
Totals	131	244	132	123	87	38		

17247. Yes, but one year may be a typhoid year, and another year may not be a typhoid year, and if 1901 was not a typhoid year, is it fair to compare it with 1900?—I may say that the chief incidence of typhoid in Yarmouth in the previous years was rather in the winter months, not at the usual seasonal time.

17248. Well now, take Southend, for instance. You say here that in Southend out of 105 cases of typhoid fever 82 cases—well, that would give a percentage of about 80 per cent. of the total number of cases—had some connection with shell fish apparently?—Had some connection with shell fish apparently.

17249. Is not that an enormous proportion?—I think that the amount of connection between shell fish and typhoid fever in the past has not been sufficiently estimated. I think we want to make inquiries not only into the eating of shell fish, but into the handling of shell fish. It is quite conceivable that if a person handles infected shell fish—even if he does not eat them—if he does not wash his hands he could easily convey the germs to his mouth.

17250. Do you mean the Commission to be under the impression that you consider very nearly 80 per cent. of the total cases of 1902 were due to shell fish?—I say that as far as my researches went shell fish were the most probable source of those cases.

17251. Of the whole?—Of the 82. I could find no other circumstance.

17252. Is not Southend what we call a typhoid fever town?—It has hitherto been supposed to be so, but they have had house-to-house inspection since 1897. I doubt if there is another town in the kingdom where as much attention has been paid to the drainage, and its water supply is absolutely pure, and yet it has had an excess of typhoid fever.

17253. Now what was that attributed to before your report here attributing it to shell fish?—Chiefly attributed to pollution of the soil.

17254. And to the drainage, was it not?—Naturally to the pollution of the soil.

17255. To the drainage?—To the drainage? Yes.

17256. I see in your report you state: "I quote from the annual reports the opinions of the medical officers of health as to the causes of the endemicity of typhoid fever in Southend. In 1893 the then medical officer of health recorded his conviction that 'the sewers are the cause of this endemic typhoid state.' He repeats this expression of his opinion in his report for 1894." Then you practically go on each year quoting his opinion, showing that Southend was a typhoid fever town, and that the sewers were bad and the soil polluted. And then you say also that the medical officer of health for the time being, impressed with the fact that "in spite of improvements in the sewerage system, together with the house-to-house inspection and the remedying of all defective drains, the borough is not as free as it should be from enteric fever," made more careful inquiries into the question of shell fish as a source of infection, and reported that 25 cases out of 55 originating in the borough were due to shell fish?—Yes.

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* It is expedient here to quote the exact figures of typhoid notifications in Yarmouth for each month of the years 1897 to 1902. It will be noted that after a series of years of endemic typhoid, the sale of mussels was stopped in 1900. In 1901 there was a marked reduction in the number of notifications, and a still further reduction in 1902.

* Excess of Typhoid Fever in the winter months of these years attributed to mussels taken from the Yare.

17257. That is a very great change of opinion between 1895, I think it is, and 1902?—At that time, in 1895, no inquiries whatever were made into the question of cockles. If you will kindly look down three or four paragraphs below that you will see that I say that "the medical officer of health, reporting on 63 cases of typhoid fever which occurred in 1897, states that five were secondary, and as regards shell fish he writes: 'In only one case could the cause be traced to shell fish, and then not definitely.' He still ascribes the majority to defective drains and soil pollution. However, in his report of 1898 the above statement is qualified as follows: 'In 1897, although several persons notified had eaten shell fish, in only one could the cause be traced to oysters.'" That is to say, the inquiries had only been made with respect to oysters; it did not cover cockles.

17258. Quite so, but I find also that Dr. Bruce Low, in 1896, in a report to the Local Government Board—and the medical officer of health agreed with him—speaks as to "the endemic prevalence and seasonal development of enteric fever at Southend being due to sustained befoulment of the superficial soil"?—Yes, and I maintain that we have now got rid of any such cause of enteric fever in Southend. I have not found any evidence that these cases of enteric fever which occurred last year, in 1902, occurred in houses or in parts where there was this previous pollution of the soil. A large number of the cases occurred in new houses where there were no sanitary defects. The only one matter that was common to the great majority of the cases was the eating of shell fish.

17259. Of course, I do not for a moment suggest that there is not a certain percentage—possibly a large percentage—of cases of enteric fever caused by shell fish; but I want to get at whether you really consider that you are not overstating the case when you suggest to us that 80 per cent. of the total cases at Southend in 1902 were caused by shell fish?—I state "had some connection with shell fish." I found that there was some connection with shell fish in 1902 in all those cases.

17260. I want to get—if you have made it up in your own mind—what the percentage precisely is?—In this special report I venture to state that I believe that if the eating of shell fish were abandoned in Southend the incidence of typhoid fever would lessen by fully one-half.

17261. Then you think there are 50 per cent.?—I really understate the limits of my belief.

17262. (*Sir William Ramsay.*) Is it not the case that typhoid fever is conveyed by the excreta of typhoid fever persons; are these always destroyed?—Directly a case of typhoid fever is notified to me we take every precaution to have the typhoid fever excreta destroyed before they are put into the sewer at all.

17263. (*Mr. Stafford.*) You say that you think you have secured a decided diminution in the incidence of typhoid fever in Southend, and at any rate the borough of Southend has been practically free of typhoid fever since January last?—Yes.

17264. That is from January of this present year to the present date?—To the present date.

17265. What are the months in which typhoid fever is usually prevalent in Southend?—It is most prevalent in the month of September—the most marked prevalence in September.

17266. Is it not rather early then to calculate that you have done very much to stop it when we are now only dealing with the period between January and May?—I can only state that there have been no cases except one imported case from another district.

17267. (*Sir Michael Foster.*) What has been your incidence in January, February, and March in previous years?—There has been a monthly mean level of about five cases in January and three or four in February, one or two in March, and two or three in April; altogether I would reckon with the usual number of cases.

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17268 And this year you are practically free; one does not quite know what "practically free" means?—There have been only two cases since January; one was an imported case where the infection was evidently received elsewhere, and the other was in my opinion probably due to eating of watercress—those are the only two which have been notified.

17269. One imported case and another a local case?—And another a local case.

17270. And of the five before, would probably one or two of them have been imported and the rest local?—Which?

17271. In previous years five, what is about the ordinary proportion of imported cases to Southend, the endemic cases?—I cannot state exactly at the moment.

17272. Roughly?—Well, of those cases that were notified in June and July last year one was imported.

17273. (*Mr. Stafford.*) During what months do they eat shell fish, chiefly, at Southend?—The shell fish shops are shut from October. They open again just for the Easter holidays, and close again directly after Easter Monday, open again about Whit Monday for the Whitsuntide holidays, then the cockles are sold practically from that time.

17274. What are the months of your largest consumption?—Oh, undoubtedly July, August, and September.

17275. The months in which this recent epidemic occurred in Southend were the months of June and July, were they not?—The cases began in June and continued to October. A later note, dated 1st October, will be found at page 18 of my special report.

17276. That does not correspond with the consumption of shell fish?—June and July; on the contrary, I found that nearly every case that had typhoid fever had eaten cockles.

17277. I thought you told me now that they did not commence to eat them in large quantities until July?—I found that nearly every case that had occurred in June had eaten cockles, though the general consumption might not be so great until July. It is rather a point in favour of the cause of the disease being cockles, that if the comparatively few that ate them in the end of May and June, of those comparatively few, such a large number had typhoid fever.

17278. Yes, but the incidence of the disease was chiefly in June and July?—Last year; and if you will kindly look at the table that I have at page 16 of my special report, you will find that I attribute the probable source of infection in the cases that occurred during June, 10 of them to cockles, one to oysters, one was imported, two to uncooked vegetables; while in four the source was dubious, though one or two of those admitted having eaten cockles at the same time, and still I put them down as dubious.

17279. And none of these cases in your opinion could be attributed to local sanitary conditions?—No. I may say in the whole lot of those cases there were only two houses in which sanitary defects could be found.

17280. Then the soil must have undergone a very great improvement since 1895?—I should say, decidedly.

17281. Because up to 1898 everything is attributed to the condition of the soil or the condition of the drainage?—Yes, and I contend that the real cause was overlooked.

17282. Quite so, yes?—Which was the shell fish.

17283. And that the soil was not polluted then?—I do not think it is now. I have no evidence that it is now.

17284. (*Sir Michael Foster.*) When was the water supply established?—Some years ago.

17285. (*Mr. Stafford.*) That is beyond suspicion, I suppose?—Beyond suspicion; it is got from deep wells, which are well removed from all sources of pollution, under excellent management, and bacterial and chemical analysis of the water shows that it is of excellent quality.

17286. (*Sir Michael Foster.*) Do you think those five or so cases which occurred in previous years, as compared with the one case you have in this year, were due to shell fish?—I think so, sir.

17287. But your shops are closed in winter?—Oh! but people sometimes collect, newcomers particularly

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so, shell fish from the foreshore between Leigh and Southend, and the cases I have generally found that occur in the winter months have actually taken shell fish from the foreshore both last year and in January; there were three cases before this time of freedom from typhoid, and every one of those cases had taken oysters from the foreshore.

17288. (*Dr. Burn Russell.*) Have you had occasion to investigate any outbreak of enteric fever, originating in milk?—I have had no reason to suspect milk supply in connection with this.

17289. That is not the bearing of my question?—I beg your pardon then, sir.

17290. Have you had any experience?—Apart from Southend?

17291. Yes?—No, sir.

17292. It is that reference to this feature of diarrhœa; I suppose, although you have not had personal experience, you know, as matter of record, that it is a common feature to have a considerable amount of diarrhœa in epidemics through milk?—Through milk, certainly; milk epidemics have been described, undoubtedly.

17293. It is a feature. Then when you had taken this shell fish census of the population, did you find that the two classes of the community presented any marked differences in their social position or sanitary circumstances?—None whatever.

17294. Indiscriminately from all classes?—Quite; and the cases of typhoid fever occurred in different parts of the borough. They were not limited to one district, they occurred in different parts of the borough; they occurred amongst the better class houses, and amongst the poorer houses; the one exception was that a considerable proportion of them occurred in shell fish vendors, and their employees.

17295. Still, I suppose, while you are convinced that the use of polluted shell fish is a *vera causa*, in the investigation of the origin of typhoid fever, you are satisfied that it is necessary, in view of what we know as the characteristic of typhoid fever, to be cautious in any absolute estimate of the precise extent?—Certainly, and I made very careful inquiries both into the water supply and the milk supply in each of these cases, and in my special report I have put in a table showing the milk supplies, and I also inquired into the sanitary conditions of the houses. These were always carefully inquired into, and I also inquired into other food supplies, such as uncooked vegetables.

17296. In fact, you covered all the known causes so far as you could?—So far as I could.

17297. And this was the only condition which bracketed the whole lot?—The only condition which was common to the majority of the cases.

17298. As to the inspection of registered layings and other sources of shell fish, you would not propose to give the trade any direct power in the administration of any law that should be passed on the subject?—I do not think they ought to have any more power than is given to other trades.

17299. Exactly, just as with butchers, one always consults their societies with reference to the consideration of the bye-laws, and that sort of thing, but you would never think of giving a butcher anything to do with the administration either as an individual or as a society?—Quite so; that is what I wished to suggest.

17300. (*Colonel Harding.*) Merely this question with regard to the vendors of shell fish; you have satisfied youself that there is exceptional disease amongst them?—There certainly was last year.

17301. And do you find in your experience that these shell fish vendors are exceptional indulgers in shell fish?—Oh, yes, they all eat shell fish.

17302. Eat freely?—Yes; that was the argument some of them brought forward: "I eat shell fish every day, and I have never been ill; how can you attribute this typhoid fever to shell fish?" I have argued with them; it is the same as other poisons; if you get accustomed to a poison you do not feel it. A person who is accustomed to smoke cigars can smoke them every day without feeling it in the least, but give a boy a cigar and it will make him dreadfully ill. It is a question of having got accustomed to the poison, or having previously had the disease in a mild form.

17303. Then you have not been led to suspect shell fish apart from the contamination?—Oh, no. I do not suggest that for a moment, not apart from the contamination; in fact, I think the findings of Professors Klein, Boyce, and Hewlett show clearly that shell fish in their natural condition do not contain these organisms that are found in sewage, bacillus coli, and bacillus enteriditis sporogenes; therefore not the typhoid bacillus either. I should think if the conditions were good that shell fish would be a very valuable food.

17304. (*Sir Michael Foster.*) Just one question about the registration authority, and the appeal from it. One can hardly have an appeal from the Local Government Board itself, but probably the thing would work out in this way, that there would be first of all a minor registration authority?—The sanitary authority itself perhaps.

17305. Well, the sanitary authority, or some rather large sanitary authority, say, corresponding to a Rivers Board, which might in the first instance determine the question of registration?—Yes, sir.

17306. From which appeal might be made to the Central Board?—To the Central Board; that was really more the thing.

17307. That was what you had in view?—Yes.

Mr. WILLOUGHBY JOHN BEAN, called; and Examined.

Mr. W. J. Bean.

17308. (*Sir Michael Foster in the Chair.*) You are an oyster merchant in Essex?—Yes, sir.

17309. And you have a very large business in oysters?—A considerable business, yes.

17310. Which is, I think, of very old standing?—Yes, sir. The business at West Mersea was carried on by my grandfather, at any rate, 70 years ago.

17311. And you have laid before us a paper concerning the present question containing certain views?—Yes, sir. The paper is as follows:—

The cultivation of oysters and other shell fish round the coasts of the United Kingdom is an industry of the highest importance to the nation, inasmuch as it produces food, employs labour, directly and indirectly, to a large section of the community, and serves as a school for sailors of both the navy and merchant service.

The industry is suffering greatly from the results of the "Typhoid Scare."

That bacteria common to sewage are found on shell fish beds and in shell fish in proximity to sewer outfalls, which furnish strong circumstantial evidence that typhoid germs can be conveyed by shell fish into the human system.

The questions therefore arise:—

How far is sewage, in connection with shell fish, dangerous, and where does the danger begin?

How can the danger be removed or minimised?

Who are the parties guilty of contaminating shell fish beds?

Who should be responsible for contamination and its removal?

It is known to, and has been demonstrated by medical authorities, that there are present in crude sewage (in relation to its bulk) enormous numbers of bacteria, of at least two different kinds, which are commonly found in the intestines of human beings. Medical science does not appear, at present, to have demonstrated that these are harmful to the human system; unless they may be if reintroduced in large numbers, but it is generally conceded that their presence is to be deprecated in any food or drink.

Crude sewage, being more or less solid, will, on leaving the sewer outfall, travel in suspension with the tide or current for a considerable distance before sinking to the bottom, and thus carry crowds of bacteria on to shell-fish beds that may be on its course.

It is obvious that by a proper and thorough system of filtration this danger is considerably reduced, though, up to the present, no experiments appear to have been made to ascertain the relative proportions or relative amount of danger. I desire to urge most strongly the necessity of these experiments being at once instituted.

Again, it is probable that the effluent from properly filtered sewage floats on the surface of sea water, thus minimising danger. A study of this is also very advisable. If it is still found that there is danger in clear effluent, it is possible that means may be found to destroy any dangerous bacteria left.

I am of opinion that, as shell-fisheries are a valuable national asset, that the nation should use every endeavour to preserve the fisheries, and I would start any administrative suggestions by a general rule that the proprietors of any fishery are entitled to compensation for damage or confiscation.

That no fresh system of drainage should be allowed which endangers any fishery, unless it is shown that no other course is available, and that such drainage is necessary. In such a case the county, or group of counties, in which the area to be drained lies, should be liable for the compensation.

With regard to any present drainage which is shown to contaminate any fishery, the system should be altered at the expense of the local district owning, or having charge of the system; or if that cannot be done then the owner of the fishery should be compensated by the county, or group of counties.

It should be illegal to establish a new fishery in dangerous proximity to any present system of drainage.

From fisheries which are shown to be contaminated no shell-fish should be allowed to be sol dfor consumption, unless the shell-fish have been laid for a period (to be determined) in water which is not contaminated.

The Local Government Board should be the authority for enforcing the above suggestions. The Board should pay all expenses of administration, except compensation. It should appoint inspectors and arbitrators.

The inspectors should be medical men who also have a practical knowledge of tides and currents, they should also be expert bacteriologists, able to analyse shell-fish and water in the laboratories to be provided for that purpose by the Board. Their duties should include and they should have power to inspect public and private fisheries and take samples (paying wholesale market prices for same), and to report results of analysis.

The arbitrators should hold inquiries previous to closing, either permanently or for a time, any beds, or to determine the amount of compensation to be paid for closing or damaging any beds, and for determining who shall pay, and in what proportion shall be paid, such compensation. In determining such amounts care should be taken that the occupiers, as well as the owners, receive compensation.

17312. Well, we may take for granted, I think, that the oyster fishery trade or the shell fishery trade is a matter of national importance; that is one point?—Yes, sir.

17313. And that it is very greatly suffering from the so-called typhoid scare?—Yes, very greatly indeed.

17314. And that one may say in the interests of the nation it is most desirable that the evils of that typhoid scare should be prevented in the future?—Yes, there are so many indirect advantages ensuing from the cultivation of shell fish that, I think, apart from the question of food, it is a national matter.

17315. As you say, your fishermen have become sailors in the Navy and Merchant Service?—Oh, yes, a great many of the sons of fishermen are brought up for a time on the boats on the coast; they then go into the Navy, or into the maritime merchant service.

17316. Perhaps we need not discuss with you, we may take it for granted, that there is a very considerable evidence that illness, and especially typhoid fever, is communicated by means of contaminated oysters?—You must not take it as evidence from me, sir.

17317. May we discuss the question on that hypothesis?—Yes.

17318. I mean we need not enter into that question with you, need we?—I put it, there is strong circumstantial evidence that it can be or may be conveyed.

17319. Quite so; at all events we may discuss what should be done on that hypothesis?—Yes.

17320. That there is a very large amount of evidence with regard to this question, sufficient to justify steps being taken?—Certainly, there is quite sufficient to justify steps being taken that I agree with entirely.

17321. I see, in your paper, you observe that with a proper and thorough system of filtration the danger of bacteria and other organisations being carried is considerably reduced?—Yes.

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17322. But there is a good deal of evidence, is there not, that the number of organisms, even in the ordinary systems of sewage with a very clear effluent, is very considerable?—I do not know whether there has been any experiment made at all in relation to that, especially with relation to effluent that is turned into tidal waters.

17323. I think I may say we have a considerable amount of evidence that even in effluents which are chemically beyond reproach there is a very considerable number of bacteria still present?—I do not know whether you want me to agree to that; I really do not know that.

17324. You say you do not know that; I have just stated that to you?—I see, yes.

17325. That there has been a very considerable examination, from a bacterial point of view, of effluents from various sewage systems, various methods of disposal, including land treatment, and in all cases, even with the land treatment, a considerable number of bacteria are present; so that the idea that the mere treatment of the sewage by any method would do away with the possibility of pathogenic organisms being carried by the sewage has no foundation?—You see, sir, I say that it is considerably reduced; I do not say it is done away with. Up to the present we have not been able to learn what the difference is between effluent which has been properly treated and crude sewage; there must be considerable difference, it stands obviously to reason.

17326. I think I may say this, that the reduction of organisms has no proportion to the reduction of noxious qualities?—No, sir, but it may be that the effluent does not carry those bacteria which it contains anything like so far as crude sewage would; crude sewage undoubtedly would travel.

17327. You mean mechanical carriage of suspended matter. That is quite a point that one recognises?—I know that in some cases oyster beds have been shown upon analysis to have coli communis upon them, which are a good way away from the sewage outfall. It is possible that if that sewage had been properly treated the coli communis would not have been found on these oyster beds, although they may have been found nearer to the sewage outfall. I do not know whether experiments have been carried out to prove or disprove that. I think they ought to be.

17328. Possibly our interview with you will be most fruitful if we confine ourselves mainly to the question of administration and compensation?—What you please, sir.

17329. We note your suggestions which you have made just now for consideration?—Yes; thank you.

17330. Now, with regard to the administration for the correct carrying out of all that is necessary from the point of view of health and the fishery industry; have you considered the question of registering and authorising the various layings and pits?—Yes. I have thought over that a good deal recently. I am of opinion that a Government guarantee of some sort is necessary to restore the confidence of the public in shell fish, and it seems to me it is only a question of how that guarantee can be given. It must be given in some ways by an investigation by the Government to show that all fisheries from which shell fish are allowed to be sold are pure, sufficiently pure for the public to use, and that, of course, carries with it a certain repressive measure that other fisheries which they do not guarantee should not be allowed to send their shell fish into the market directly from the beds, at all events. In my opinion, it comes down to some method or other of carrying out that restriction and guarantee.

17331. Well, now as to the machinery for bringing that about. We will suppose that certain fisheries are registered, at all events for a time, as supplying oysters which may be eaten by the public?—Yes.

17332. And that the sale of oysters or shell fish, we may use it generally, is only permitted to those fisheries. Then have you any suggestions to make as to the authority which should determine that registration and authorisation?—I consider myself that it should be the Local Government Board, because in the first place the Local Government Board are the authority for enforcing and permitting drainage, and if they have the power to examine and give guarantees for oyster beds or for shell fish beds, the whole thing will be in the hands of one authority—the authority who is responsible for the drainage and the authority who

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would then be responsible for the purity of the shell fish industries.

17333. That is an argument in favour of putting this power in the hands of the sanitary authority as compared to any fishery authority?—Yes.

17334. Then with regard to the sanitary authorities, there are the local authorities and the central authority—the Local Government Board?—Yes.

17335. Supposing that there were instituted some large sanitary authorities corresponding, for instance, to a watershed, a large sanitary authority for the whole of a watershed district, possibly there would be more counties than one entering into the composition of that board, would you be willing to entrust the determination of the registration to such a board, subject to an appeal to a central authority representing the Local Government Board?—I do not think it would be so wise as it would to make the Local Government Board themselves the authority, because at the present time the drainage, although it is nominally in the hands of local sanitary authorities, is really in the hands of the Local Government Board centrally. The local sanitary authority institutes a system of drainage which is then inquired into by officers of the Local Government Board.

17336. I was distinguishing between a small sanitary authority and a somewhat large sanitary authority?—Yes.

17337. Which would have much greater powers, and which would be much more completely equipped for the investigation and determination of such cases than a small sanitary authority, and the employment in the first instance of that inferior or subordinate sanitary authority would have the advantage of leaving an appeal to the higher central authority. If you leave it in the hands of the higher central authority, what appeal have you against that higher central authority?—Well, I do not know that an appeal would be necessary, provided you follow out, or provided they follow out, the suggestions that I give with reference to compensation.

17338. (*Sir William Ramsay.*) But, perhaps, it would be just as well to state the mind of the Commission as regards another question entirely, namely, the disposal of sewage. I think I may say the Commission generally have got the notion that Rivers Boards all over the country should be the first authorities, the subordinate authorities, to regard the matter not from the point of view of county, but from the point of view of the whole watershed. It is a proposal to extend this system so as to give such, what we may call subordinate authorities, the control of the shell fish of such a district, so that the disposal of sewage would not, as it has been in the past, be entrusted to the individual local County Councils, but should be entrusted to an authority composed of groups of these County Councils which happen to belong to the same river shed?—You see, in that case you are putting into the hands of the very people who may have to pay compensation the handling of the fisheries and the decision as to whether the bed is contaminated or not. I am rather of opinion that it should be in the hands of an absolutely independent party, who could sit upon it, and say so much compensation shall or shall not be paid, and so and so shall pay it. If you are going to put it into the hands of a county to decide this, and the county has got to pay, well, we know perfectly well that the merchant will go to the wall.

17339. (*Chairman.*) I was going to ask you about the question of compensation after we had talked some little while about the central authority, but it looks as if we had better consider the question of compensation first, and then we can return back to the general authority. Now, your view in the first instance is that the proprietors of any fishery are entitled to compensation for damage or confiscation?—Yes; it is following out practically what is general law. I am not saying the damage is proved at once; it means when it is proved. It is a sort of common law, I believe, that a man is entitled to compensation from any person or authority who damages his property.

17340. Then you go on to say that no fresh system of drainage should be allowed which endangers any fishery unless it is shown that no other course is available, and that such drainage is necessary. In such such a case the county, or group of counties, in which the area to be drained lies, should be liable for the compensation. With regard to any present drainage which is shown to contaminate any fishery, the system should be altered at the expense of the local district owning or having charge of the system. In the one case you throw the burden on the local district, and in the other case you throw it on the county at large, or the group of counties?—Yes.

17341. Why do you make that distinction?—I do not altogether make a distinction; you see it is a question of new drainage and a question of altering existing drainage. The present drainage is instituted; it is there, it has got to be dealt with somehow; it has been put in for the benefit of certain parties.

17342. For the benefit of the local district?—Yes.

17343. Then why should not the local district compensate?—The local districts I think should alter, because they have received the benefit of the drainage up till now, therefore they ought to be at some expense for alterations, but if they cannot be altered then I think the compensation should come under the general rule, and I consider that the general rule should be that the county, or any group of counties, as may be determined, should bear the expense, because I think that the whole movement is a national one, and that the business of new drainage which is required by a new place so starting, or a place that is getting more populated, should not fall entirely on that district as a very heavy burden. As a general rule, all new drainage schemes are very heavy burdens, but if it is going to be made still more so than it is to-day, then I think that it ought to be spread over a wider area, as it is a national object, therefore a considerable proportion of the nation should join in the expense.

17344. Why not the whole nation if that is the case?—Well, I was afraid to say that. I do not know really why it should not be, but as we have nowadays got down in local politics to a system of county councils, we might perhaps make the area a county instead of making it a national, or instead of making it a parochial thing.

17345. Yes, but on the supposition that there should be established in the future those authorities supervising what is taking place in the whole of a watershed as being the natural division of a country into areas; on that hypothesis the authorities of that large area would be able to determine what should be done or what should not be done, also to make suggestions as to how the compensation should be met?—Yes, I do not, of course, know what those areas would be; how you are going to define them.

17346. Take a watershed?—I do not know how you are going to define them by a watershed exactly, because you must come down to the sea to the boundary of something absolutely or strictly, it must either be a parochial boundary or a town, or a rural district, or an urban district, or a county. If you take a watershed it takes parts probably of some parish, parts of counties for certain.

17347. Yes, but that is the view that the natural conditions, which are really the determining facts in this matter, should supersede and override all other considerations, and that you shall have an authority for the watershed in which the various districts of that area should be represented?—Yes.

17348. That would be a large authority for the whole of a large area, which could hardly be if it were called upon to do anything on behalf of the nation as you represented. I suppose it would be able to do that, but at all events it might be trusted to consider each question on its own merits as far as its lines permitted?—I should like, sir, if I may, to have your idea of what you mean exactly by a watershed; you say the land which a river drains.

17349. Yes?—Well, take, for instance, in my neighbourhood we have Woodbridge River, the "Deben," which only drains a very narrow area on each side of it. It may go up a certain distance into the country, but almost immediately against it you have the Orwell. That takes a wider area under the same distance. Then you get the Stour running into the same estuary, and so you go on—the Colne.

17350. Quite so, that would be definitely settled afterwards what the area should be. It is the idea of dividing the country into large areas which were determined by the water flow, not necessarily limited to each particular flow, I suppose, but saying that an area belonging to one flow should not be mixed up with an area belonging to another flow.

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17351. (*Sir William Ramsay.*) Does Mr. Bean not know of the existence of the Mersey and Irwell Water Board and others similar?—I know there are water Boards, but I do not know what area they take in.

17352. (*Chairman.*) They may take in several rivers?—If the idea is to divide England up into six or seven districts there is no doubt the area would be quite sufficient to pay for compensation. We have then to take into consideration that the area shall be sufficiently large to pay for compensation, and, of course, it is quite possible to define it exactly. I should not mind that at all. You see, my position up to the present has been that I know there are county councils, and know that there is a Local Government Board; beyond that I do not know a very great deal about the authorities.

17353. Quite so. I take it that if the area were large enough to counteract selfish tendencies, would that meet your view?—Precisely, that is so.

17354. And, of course, if there were a subordinate authority delivering judgment in the first instance that would give the possibility of an appeal to the central authority, and you have all the advantages of appeal; generally, humanity likes to have an opportunity of appeal?—That is quite right, sir, so far as the shell fish merchant goes in the direction of restriction and compensation, but what about the sanitary authority, who has the right of drainage? You will give this new authority the right to prohibit.

17355. This new authority would be the authority on all these matters. I mean, supreme, subject to an appeal to a higher central authority for the whole kingdom?—That would quite satisfy me, I think; it would be a very good arrangement.

17356. You think that the arrangement would probably lead to a satisfactory adjustment of all the various questions relating to the oyster and shell fish fishery?—I should think it would. They, of course, would appoint their proper inspectors.

17357. Such an authority in the first place, a subordinate authority, would be adequately equipped with all the necessary technical skill in the way of advice and officers, and so on?—Yes.

17358. And the central authority would have the very highest skill that the country could provide?—Of course, it is not quite for me to suggest anything more definite than that, but you notice that I do make suggestions with regard to where funds are to come from. If the area which you speak of is large enough they can, of course, pay for the inspections and registrations, and so forth. At the present time I have only divided the case into two heads, one for compensation and the other for all the rest of the business. I have made that practically national, and the other, compensation, more local. But if you are going to put them both under one authority it will come to a large local payment, will it not—a large area?

17359. A large area, yes?—I think that would be all right.

17360. (*Major-General Carey.*) If an oyster bed was laid down after the drainage had been carried out do you consider that the owner would be entitled to any compensation?—No, I have put it this way. Here I have not laid a general rule for this. I say that no fresh system; it should be illegal to establish a new fishery in dangerous proximity to any present system of drainage.

17361. In the future?—It should be illegal.

17362. In the future?—Yes. With regard to the past I understand from inquiries that I have made, I find that in many cases it would be difficult to say which was there first—the fishery or the drainage, and therefore I have thought——

17363. (*Chairman.*) You can say that in many cases, can you, Mr. Bean?—From what has been told me,—partly hearsay, you know—I know one or two cases in which it would be a little difficult to discover, and I think that in starting something which is absolutely fresh, which could not be contemplated at all at either the time the drainage or the fishery was established, that the matter should be left entirely on one side, and the nation should say we are prepared to compensate owners of properties that have been established in the past, whether rightly or wrongly.

17364. (*Sir William Ramsay.*) Whether it means the removal of the drains, or whether it means the removal of the fishery, because both cases might occur?—Both cases might occur. You should know, for instance, that we had a very strong argument brought before one of our associations the other day by the gentleman who holds the fisheries at Emsworth—the Chichester business. He said, "I knew that there was a drain not a great way from my ground years ago, but there were only one or two houses that had any connection with it whatever." It was mostly storm water, he said; there was another house joined on to it, and then he got something besides rain water, and so it went on from another to another. He said, "How was I to understand when the fever point was arrived at; I am not a sanitist. I do not know; I do not even know to-day that typhoid fever can be conveyed by oysters at all." He turned round on the whole company, and said, "Who can say so?" I was obliged to support him to some extent. Now, the point as put to us is, which of us can say that our oyster beds are absolutely free from pollution. It is a matter of theory to us to some extent. Analysts come and find out for themselves, but they do not tell us; we do not know exactly, therefore I do not think it altogether fair to say a man was doing wrong in the past if he put his oyster bed near the drains; perhaps rather more the other way, if a man brought the drain to the oyster. But I would like to pass that altogether over. I do not think it should be inquired into too strictly. I simply say it should be altered in the future, and that the nation should pay compensation which ever way it comes, either pay for the altering of the drainage, or pay for doing away with the oyster beds.

17365. (*Colonel Harding.*) I should just like to ask Mr. Bean on the question of compensation. I gather that your opinion is that compensation is a more or less temporary incident; that in the course of time you would consider an oyster merchant who places his growing beds or storage beds in the neighbourhood of drains to be personally blameable, and, therefore, not to be eligible to receive compensation.

17366. (*Chairman.*) It is a little more than that according to the present system; I understand Mr. Bean refers to registration. A person who proposes to place an oyster bed in the neighbourhood of a drain would not be allowed to register?—Exactly.

17367. Therefore, would have no power of selling his oysters?—I say absolutely it should be illegal for a man to do so, therefore he would not get compensation, but in the past, I gather something from your question; in the past the compensation will sometimes be for the closing of a bed until the drainage is put right.

17368. (*Colonel Harding.*) Then are you of opinion, continuing my question, that the compensation expenditure would be more or less temporary?—I should say in a very great many cases it would.

17369. It would not be likely to arise when it was well known that it was not legal to place oyster beds in dangerous positions, or to bring drainage to the immediate neighbourhood of oyster beds?—Yes, it practically would not arise in the future. You see in fresh cases—it would only be in the case of the present fisheries.

17370. Your idea of compensation would be only of a temporary character, dealing rather with the past than with the future?—There may be a case or two, there may be several—I do not know—where it would pay the area better to close an oyster bed permanently, and pay the value of it rather than definitely alter their system of sewage. It might occur so.

17371. (*Chairman.*) But there might be a compensation. There had been an oyster bed where the pollution was scanty or absent, going on for some time—I mean when registered—free from pollution whatever, and then suddenly there sprang up a village or a town, an establishment, a large population, which was obliged to throw its drains in the neighbourhood of the bed, and unable to carry out adequate precautions to keep that bed fit for registration?—Quite so.

17372. Compensation would come in then?—Yes, that almost comes under the heading that fresh systems of drainage should not be allowed unless it is absolutely necessary, does it not?

17373. Then in that case it would be for this authority to determine whether the nation's interests would be better served by refusing the drainage, or by compensating the oyster beds?—Quite so; that is so.

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17374. (*Colonel Harding.*) But that would be scarcely compensation in the sense that we understand it as applying to a larger district; that would be compensation by the person who causes the injury to the person injured, would it not?—Well, I do not know really how it ought to be done. I would like to be fair, but it is rather difficult to see under a case of that sort whether it would be just to local area, the town or the village.

17375. Is there no remedy at common law for an oyster merchant to whom sewage is thus brought against his own protest?—I am afraid there is not. Probably some of you gentlemen know more about it than I do, but I believe in the Public Health Act, 1875, an authority can turn his drains into any river or tidal water, which is not declared a stream, and that process of getting waters declared by the Act a stream is rather a difficult one. I think there has to be a public inquiry instituted by the sanitary authority of the district.

17376. Then your impression is that there is at present no remedy at common law?—No, I think it has been looked into several times, but I do not think that one has been found; I do not remember a case any where.

17377. Would the case be met if the law were so modified as to give such remedy to any oyster merchant to whom sewage was thus brought?—I am afraid there are so many cases in which sewage is turned into local streams to-day that it would be difficult to get such an Act passed.

17378. But at all events it would appear as if the compensation should rather be paid not by the large area but by the offending community?—It does appear that with regard to any future town growing up to some extent, but I do not think it does altogether to those which are already in existence, because, as I have said before, either the oyster merchant brought his fishery close to the drain, not knowing that he was doing anything harmful, or else the town brought the drainage there in the same way, not knowing that they were doing anything harmful.

17379. I should like to form some idea as to the extent of the compensation to be paid, would it be a serious matter, supposing an oyster merchant has certain storage pits in that position, which are threatened by the advent of a sewage drain; would it be a very serious thing to compensate him for the removal of those to another position, or would it be more or less of a trifling character, which would readily be met by the local authority itself, which was proposing to carry out this change?—I think very likely in the matter of storage pits alone it could be met by the local authority.

17380. Then it would only be serious in the case where oysters are grown and developed and fattened?—And fattened.

17381. And in that case might it be a serious amount of compensation?—Oh, yes, it might be very serious.

17382. (*Chairman.*) There it would be the fact that only certain areas are suitable for the breeding and fattening?—Certainly, that is so on the Essex coast, close to the Thames esutary, for instance, or take the Thames estuary as being the home of the native oyster, which is supposed to be, and probably is, the best oyster in the world. Even in that we find some grounds that fatten much better than others—more regularly even than in rivers; that some parts of a river fatten better than another.

17383. It varies with the seasons; one part one season will fatten, and one another. Excuse me interrupting, you have made a great many observations, have you any idea what determines the fattening quality of the locality; have you formed any idea yourself?—Apart from the season, you mean?

17384. Apart from the season, why a certain part of a creek is a good fattening part?—My impression is that to a great extent it relates to the closeness of the subsoil, the clay, to the surface on which the oysters rest.

17385. How does that influence the matter?—That I cannot say, that is beyond me; but in some instances the matter of the current determines it. You get a certain watershed, bringing down probably vegetable food from the ploughed land, and the current takes this food over a certain oyster bed more than it does over another one in the same river. There are eddies and currents in various sorts of directions in every river; I think that that has something to do with it.

17386. Do you think the distance of the subsoil clay is a real factor in the business?—Yes, I do.

17387. Have you any idea how that works?—No, I go more as a matter of rule of thumb experience, I know the result; I do not know how it works at all.

17388. (*Colonel Harding.*) I suppose it is rather in connection with the storage pits than in connection with the layings that the danger arises, is it not?—I mean that for the most part the fattening beds and the growing sites are in the broader channels nearer the open sea than are as a rule the layings for storage?—Your question opens up something very wide indeed, because you at once bring up the question how far is it dangerous; where does danger begin? A good many fisheries, more particularly the large fisheries, send directly from their fattening beds without using a storage pit at all. Some of them use storage pits largely, some very little. A smaller man as a rule sends his from storage pits, but it depends a great deal upon the position. For instance, I do not know that I have got any mandate to give evidence on behalf of the Whitstable Company, but I notice they say it is only a small proportion of their oysters that goes through their storage pit. I believe at present they are not using a storage pit at all.

17389. In fact, are not the storage pits an element of more danger than the fattening beds?—I do not know how to answer that question

17390. Speaking generally, the fattening beds are not as a rule in the narrow rivers or in the immediate neighbourhood of a station, or a town, or a village, but are in the estuary nearer the sea than are the storage beds?—I do not know whether that argument will bear looking at very closely. For instance, at Chichester—Chichester Harbour I think they call it—the Bosom fishery. I believe the Fishmongers' Company have analysed a matter of five miles away from the town in the bed of the river, and found that the oysters or the water contained *coli communis* at least, if it did not contain anything else. That is not a storage bed at all, that is a fishery. On the other hand, I know a storage pit in the Colne at Wyvenhoe, which has just recently been closed, which undoubtedly was dangerous. There was a sewer coming out alongside of it within a matter of feet, so that there are two opposite points, you see.

17391. Still, you have not said anything, I think, to shake my belief that it is generally found that the storage beds are in the neighbourhood of stations and towns, rather than the fattening beds; those are usually farther away?—It may possibly be so.

17392. And in that case, if that is so—of course, you have much superior information than I have—I am asking for information—if that be so, then the question of compensation in connection with storage beds would be a relatively small matter?—Undoubtedly, it would not cost so much to compensate for storage ponds alone as it would for the whole fishery, but I cannot altogether agree that in most cases it is the storage bed that is in fault. I believe in the Falmouth river, that there they use the grounds alone; I do not think they use storage beds, or very little. The only storage bed I actually know of myself in the West of England is the one at Plymouth; you see, for the mild weather, they do not require to be put in beds. In Essex we put them there, not only to store them for market, but to preserve them from winter frost. No doubt, they are sometimes nearer the drainage.

17393. Then, just another question on the matter of compensation: would it be necessary, if there is a fouling of the oysters, to absolutely destroy the trade of that particular oyster merchant, or would it be simply necessary to compensate him for the removal of the oysters to a safe purifying station before they were sold?—It would be a partial compensation, of course.

17394. It would be a partial compensation?—In this way you would reduce the value of his oysters at once by something considerable, but not altogether; he could sell to other people who could fatten, provided there are enough fattening beds left, but you would reduce the price of his oysters, unless he can find a storage bed in which they could be placed to recover from the fouling.

17395. Am I right in gathering then that your opinion is that that compensation would not be a very serious matter in regard to existing conditions, and that in the future it would gradually disappear?—I think it would gradually disappear myself. I am afraid that it would be fairly serious at present. Referring back to what I have just been saying about the partial compensation take for instance, Portuguese oysters. Supposing the whole of the Medway were condemned, and every merchant there was ordered to remove his oysters to some other position for cleansing purposes, these oysters are very cheap in the market, and they can only be sold as cheap oysters. If you are going to remove them when they are fat, and store them to recover, and then sell them, the price, with that added expense, would be greater than the public who use them care to pay. They are a poor man's food; it would be very awkward, indeed.

(*Chairman.*) I do not know whether in what we have been talking about just now, we have made sufficient distinction between the ordinary fattening beds and the pits—the storage pits for immediate market; it was the storage pits for immediate market, I think, that Colonel Harding had in view.

(*Colonel Harding*) That is what I had in view largely.

17396. (*Chairman.*) Which are generally placed near a station. For instance, the man at Emsworth says that is the finest spot in the world for distributing oysters over the country. These, undoubtedly, could be moved anywhere, the mere storage pits for market?—Yes, they could be moved.

17397. But the compensation for that would be slight?—Well, that depends, you see, upon the circumstances, I do not quite know what the area is like, it is so many years since I was there.

17398. But I am speaking generally over the country?—Generally over the country it would not cost anything like so much as it would to destroy a fishery, or to compensate for destroying a fishery.

17399. Or to destroy the fattening beds?—Exactly. There is something to be thought of as to the time for which an oyster should lie in uncontaminated waters to recover. I do not know exactly what it is. I believe some medical authorities have decided that if an oyster is placed in pure water for about a fortnight——

17400. For about 15 days?—Something like that; if they have only to be placed there for that time that would reduce the cost very much; if they had to be placed there for a month it means a whole month's stock at a time has to be stored.

17401. I suppose the system of registration about which we have been talking could only be for a limited time; I mean things are changing so continually; if an oyster laying were registered as good it could only be registered for a definite time, subject to renewal if the conditions remained the same?—The main oyster season in England is from August through to May. I should certainly advocate that evry bed was tested twice during that time. And then in the summer time beds that do deal in French relaid oysters should be visited again in the summer at least once. The inspection should be either three or four times a year.

17402. This system of registration should be accompanied and be based upon a system of continual inspection?—Oh, yes, certainly.

17403. Then I gather, although you spoke as an oyster merchant, and therefore have especially the interest of the oyster fishery at heart, you would be content to leave the administration of this business to the sanitary authorities, feeling there that your interest would be represented in these authorities?—Not to the local sanitary authorities.

17404. No, but to a central?—I want it particularly to be the Local Government Board as a centre, or some very large area who would be independent.

17405. Taking the large area as first authority and the Local Government Board or some central authority—some department or central authority representing the Local Government Board—as the final appeal, you would be willing to entrust these interests of fishery to that authority?—Certainly.

17406. You are aware that the Oyster Bill of 1899, I think it was, came to grief because there was an amendment transferring the administration from the sanitary authorities to the fisheries committees?—I believe that was one of the reasons.

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17407. You would be content in this case that if the fisheries committees appeared at all they would appear simply to give evidence or to appeal to this central authority?—Yes. I do not mind so long as it is absolutely a central authority—something very large—that you can say is absolutely independent. I do not mind who they are who take charge of the thing provided it is on the lines that it shall be compensation for restriction, or compensation and restriction.

17408. (*Major-General Carey.*) But referring to present conditions, would not an area such as a watershed area or a county decline to be laid under contribution for compensation to an owner for injury done by the sewers of a sanitary authority, with which it had no previous concern whatever? It had not sanctioned the original scheme; and had nothing whatever to do with it?—No doubt they would object. That is the reason why I want the Government to institute it as a fresh Act.

17409. To enforce the contribution being made by the larger area?—To enforce it, yes.

17410. (*Chairman.*) We have been speaking chiefly about oysters, I think, to-day?—Well, it is what I know more of than anything else.

17411. How far does what we have discussed relate to other shellfish—mussels, cockles, and so on?—I believe mussel beds, most of them, are public beds. I think there are one or two of them in England that are private beds. A great many mussels come from Holland that are eaten. We sometimes send mussels over from Essex to be fattened at Holland and brought back again.

17412. Is it within your scheme to propose that the so-called natural beds of the oyster should be registered? I suppose it is not. You would leave those, only it should be illegal to sell straight from any natural bed?—No. I think that areas of natural production should be taken notice of. For instance, along the edge of the Maplin Sands there are some of the very finest quality oysters that the world produces. They grow there naturally. There are not many of them collected by the fishermen. Perhaps one man gets one dozen one week, and 100 the next week, and another week none. They are gradually collected together and sold by five or six people. They are rough natives—very rough outside particularly—but white and fat inside. They will always find their way to the public unless there is some restriction put upon them. There might be something come to pollute them—for instance, the discharge of the Thames London sludge.

17413. That is what I meant. I mean it is the case, is it not, in several of these natural beds? There is an access of sewage, and possibly that is part of the reason why there are natural beds there?—It is very possible there are others. I do not at the moment know of any other public ones—I mean thereabouts. I think there are some public fisheries in the Stour.

17414. And in Ireland. I think there are some natural beds there which are distinctly exposed to sewage, and possibly thrive in consequence. Well, I suppose the parties would be served by refusing to consider those as registered beds, so that there could be no direct sale of oysters from them?—Undoubtedly that would be the simplest way, so that the oysters would have to be laid in uncontaminated waters for a time. I do not think there would be any hardship in that at all.

17415. You have put before us all you wish to put before us?—I think so.

17416. I think we have gone over most of the points of your memorandum?—I think so. I am very much obliged to you for giving me so much attention.

17417. We are much obliged to you for coming.

FIFTY-NINTH DAY.

Wednesday, 13th May, 1903.

PRESENT:

The Right Honourable The Earl of IDDESLEIGH (*Chairman*), presiding

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P.
Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, C.B., F.R.S.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT –

Dr. A. C. HOUSTON, M.D.
Dr. BULSTRODE.

Mr. J. Blamey.

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Mr. J. BLAMEY, Medical Officer of Health, Urban District Council, Penryn, Cornwall, called; and Examined.

17418. (*Chairman.*) You are Mr. Blamey, Medical Officer of Health of the Urban District Council of Penryn, and of the Rural District Council of East Kerrier, Cornwall?—Yes.

17419. May I ask you whether your experience teaches you that it is possible for typhoid fever to be conveyed to human beings by oysters and shell fish contaminaed by sewage?—Yes.

17420. And you no doubt consider that the shell fish industry is an important industry?—Yes, I do.

17421. Could you indicate to us any steps that should in your opinion be taken to prevent the shell fish from being a danger to public health?—Simply by preventing sewage coming into contact with the beds in which they lie if possible, or by preventing sites which are exposed to sewage from being used for laying down oysters and other shell fish.

17422. Have you actually thought of any practical steps that could be taken in any case that you like to take for an example. Take a case where there is an oyster bed, we will say, and sewage outfall in somewhat close proximity, would you say that the oyster bed should be moved, or that the sewage outfall should be moved?—I think it would be better to move the sewage outfall and not interfere with any local industry, if possible.

17423. (*Sir Michael Foster.*) Can that be done always?—It is a difficult matter in some cases, I think.

17424. (*Chairman.*) Well, now, could you give us a description of what actually is the state of affairs at Penryn?—The chief site for oysters at Penryn is at the lower end of the creek adjoining Flushing. But oysters are also laid on the Flushing foreshore, and immediately opposite to Flushing on the Falmouth foreshore. These last two sites are, however, outside the limits of the harbour of Penryn. All the sewage from Penryn is discharged at the outfall at Penryn quay. It is crude sewage, and is discharged into the tidal way to be carried down towards Flushing and Falmouth by the receding tide, and, I presume, back again by the returning tide. At Flushing the oyster beds are on the foreshore; crude sewage is discharged right on to this foreshore and within a few yards of the main oyster beds.

17425. (*Sir Michael Foster.*) Crude sewage?—Crude sewage, yes; and so, too, at Falmouth, though I am not much acquainted with the disposal of sewage there; but I believe that crude sewage is discharged upon the foreshore, especially at Green Bank. Immediately above this last spot there are oyster beds, so that sewage is practically discharged immediately upon them.

17426. (*Chairman.*) That is the oysters; and can you tell us anything about the cockles there?—Well, there are cockles, but very few, in the Penryn River, and there are also mussels, which grow upon the quays. There are quays there—granite quays—with huge loose granite boulders as a foundation, and these mussels grow there. I know in the past it has been the habit with the apprentices at the granite works at low tide to go down in the dinner hour and pick these cockles and mussels and partially cook them. I have had in the past about, perhaps, half a dozen cases—not only confined to Penryn, but occurring also in apprentices who live within two or three miles of Penryn, and who go in there to work. All these cases of enteric fever were, in my opinion, distinctly traceable to the eating of cockles and mussels.

17427. How far from a sewer outfall is that?—These mussels?

17428. Yes?—On the foreshore; well, from the outfall, perhaps 50 yards or more—50 or 100 yards.

17429. Have you suggested any steps for improving matters there?—Yes, in my reports; but more especially with regard to Flushing.

17430. And has anything been attempted in consequence of your reports?—Not really to deal with the thing.

17431. (*Sir Michael Foster.*) What did you recommend?—Well, I have not recommended any scheme, sir, but I recommended the better drainage of Flushing. There is a system of huge cess pits, etc., in the low-lying part of Flushing. This condition of things I considered to be very insanitary. I recommended a general improvement, and left the actual scheme to those who know better how to tackle those things than I do. I also pointed out the dangers to the public from eating oysters taken from the sewage contaminated foreshore of Flushing. I have had distinct outbreaks which I have attributed to the eating of fish from this site.

17432. (*Chairman.*) Is there a new scheme for sewage disposal under consideration at Flushing?—Yes, my Lord.

17433. And are you of opinion that it is a satisfactory one?—No.

17434. You are not?—No, my Lord.

17435. Who put it forward?—The East Kerrier District Council, to which council I am also the medical officer. They have recognised the necessity for improving the drainage of Flushing and protecting the oyster fishery if it is possible, and they have passed a resolution that something should be done. They called in, to advise them, Mr. Bellamy, of Plymouth, a civil engineer there, who has drawn up a scheme for improving the state of Flushing—the part of Flushing of which I have chiefly complained—and of dealing with the sewage. A week or two ago the Local Government Board held an inquiry to consider Mr. Bellamy's scheme and also the opposition of the inhabitants to it.

17436. (*Sir Michael Foster.*) That scheme removes the sewage entirely away from the oysters, does it?—No, sir, I do not think it would. The scheme is that the sewage should discharge, well, just a few yards down below the oyster beds.

17437. A few yards?—Yes, not more; practically, I might almost say into the midst of them, for there are oyster beds on the higher side of the quay and on the lower side of the quay, near which it is proposed to place the outfall.

17438. (*Chairman.*) Did I understand you to say that the Local Government Board had held an inquiry?—Yes, my Lord.

17439. They have?—Yes.

17440. But you have not heard the result of it yet?—No, my Lord. It is locally considered by the fishermen and those best acquainted with the tides that, supposing any sewage is discharged where Mr. Bellamy has proposed, or even should the sewage be discharged further down at the extreme end of Flushing, that such sewage would not be carried out beyond the middle of the Falmouth harbour, and that the incoming tide would carry it back again towards Flushing; for by experiments with "floats" it has been found that the outgoing tide takes them to the middle of the harbour, and the incoming tide brings them back again. It has, therefore, been considered by the objectors to the scheme that sewage would be treated by the tides in much the same way that the "floats" were.

17441. Would you have any scheme of your own that you would put forward for improving the sewage system?—No, I have not.

17442. You have not gone into that?—No, my Lord, it is rather a big thing, because if that creek is to be a safe site for laying oysters on the Flushing side and the Falmouth side, and within the Penryn authority, which reaches half way from Penryn to Falmouth, no sewage from Flushing, Penryn, or Falmouth ought to come in anywhere there. Whether it would be possible to combine the whole three places into one big scheme or not I am not sure, I do not know.

17443. (*Sir Michael Foster.*) The oysters grow in the river they call Penryn Creek?—Yes. They are taken up in the Falmouth Harbour and then put there to fatten. They say it is the finest fattening ground; from the fact, I presume, of there being so much sewage there. They say they do much better there than anywhere else. Of course, with regard to protecting the public, I presume, if any legislation could be passed making it compulsory for oysters, after being laid there to fatten, to be transferred to a site above suspicion for a certain period before delivery to the public, the oysters then would be a safe article of food.

17444. It is a very old-established fishery, I suppose?—Very.

17445. From time immemorial?—I believe so.

17446. But then, in your opinion, the whole of the fishery there is liable—and very liable—to sewage contamination?—Yes.

17447. You have traced several cases?—Yes.

17448. What has been the evidence upon which you based your opinion that the cases were due to oyster or shell fish consumption?—Well, the two main cases upon which I base such an opinion have been cases which occurred at Carclew, the residence of Colonel Tremayne, and an outbreak which occurred at the barracks at Bodmin, at the officers' mess.

17449. How many cases altogether do you directly attribute to shell fish eating?—At Bodmin the cases were reported to me by the medical officer in charge there—there were only two cases of enteric fever—but there were several cases of acute irritant poisoning, which occurred immediately after, a few hours after, the eating of the shell fish.

17450. Oysters?—Oysters, yes. And the Carclew outbreak was due to oysters as well; there were six cases, with two deaths—I think there were six cases in all.

17451. But what is the evidence, to your mind, that this typhoid fever in these cases was due to oysters and to nothing else?—Well, first of all, at the time of the illness, so as to be sure that the drainage, etc., of the place had nothing to do with it, all the drains through the place were tested by an expert, and found to be perfectly sound, and the water, I believe, was above suspicion. At this time there was a shooting party at Carclew, and the man who usually supplied the house with fish brought oysters, all of which came from Flushing. About a fortnight or so after these oysters had been supplied all these cases of fever occurred, and all those who were attacked had partaken of these oysters. Two cases actually occurred in the house, one a footman, the other one of the maidservants. The footman had a very narrow escape from death, whilst the maidservant did succumb some three or four weeks after her removal to her home when the symptoms first began to show themselves. The remaining cases did not actually occur at Carclew; one, Captain de Robeck, of the Royal Navy, had been of the shooting party and developed the fever after his return to Chatham; another, Colonel—— (I forget the exact name), went to his home in the Midlands and developed the fever after his arrival there. Both these gentlemen had eaten oysters at Carclew, and on leaving had taken oysters with them. The latter case ended fatally. Another case arose in Ireland, and in this way: when the shooting party broke up, a lady, a daughter-in-law of Colonel Tremayne's, left for Ireland, taking some oysters with her. Her brother, Colonel de Robeck, eat some of these, and he developed enteric fever. All the above cases sickened after the regulation incubation period had elapsed between the taking of the oysters and the onset of the symptoms. The sixth case in connection with this group of cases was that of a gentleman at Redruth, an architect. He, seeing the report of these Carclew cases in the local press, wrote to me saying that he thought I might like to have any evidence that might strengthen me in the view I had taken of the exciting cause of the above cases. He said that on the day of the shooting party, when oysters were supplied at Carclew, he happened to be close to Carclew, at the Norway Inn, Perranwharf. Whilst there this same man, who supplied the oysters at Carclew, stopped at the inn, and he ate some of the oysters. He returned to Redruth and went on with his business; but in about a fortnight afterwards he sickened with the fever. When he wrote to me he said he had been in bed for six weeks, and at one time was practically at death's door with typhoid fever.

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17452. With typhoid fever?—Yes.

17453. Definitely recognised?—Definitely recognised typhoid fever; these were about the six or seven cases.

17454. Then your evidence amounts to this: there was no typhoid fever in Carclew before the advent of these oysters?—Not any.

17455. A number of these oysters were sent there?—Yes.

17456. And a number of people took typhoid fever?—Yes.

17457. Including the people who went away with oysters to different parts of the country, and had typhoid fever there?—Yes.

17458. Where again there was no typhoid fever in the place to which they went?—Yes, as far as I know.

17459. And the date of the onset of the typhoid fever corresponds to the normal period of incubation?—Yes.

17460. And you have excluded all other possible causes, as far as you could tell, in the outbreak?—Yes.

17461. Drainage, milk, and so on?—Yes; it was a very definite and clear connection between the two things.

17462. Have you other evidence at all like that in other parts surrounding the creek?—Not such a group of cases. The other cases have been more or less disseminated—one here and one there, one now, and one at another time. In these cases in seeking for a cause, and after excluding all the usual causes, and at the same time knowing that they worked at Messrs. Freeman's works at Penryn Quay, and knowing also their habit of eating mussels found on the boulders forming those quays, I have got out from them in each case that a week or two before they became ill they had eaten mussels gathered at these quays. In the case of a girl in Mabe, where I could find no reason for the fever on the premises, I at last found out that an uncle of hers had picked some cockles from the Penryn river about a fortnight before the attack, which she had eaten.

17463. But, of course, a very large number of the poorer inhabitants eat cockles?—No, it is not a very general thing. There is no cockle or mussel industry at all at Penryn. A few mussels are got from the stones forming the quays, and a few cockles from the mud in the river; but none of these are offered for sale. The cockles that are sold in Penryn and Falmouth are all obtained from the Helford river.

17464. Is there any large consumption of oysters by the resident population?—No, I do not think so.

17465. They do not eat oysters much?—No, I do not think so; not many. They might in Falmouth; I am sure they do not in Penryn.

17466. What per cent. of the inhabitants eat oysters in Penryn, would you say?—What percentage?

17467. Yes; I mean not to eat them regularly, but to eat them several times during the season?—About 1 per cent.

17468. No more?—No.

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17469. How do you stand with regard to typhoid fever in the district; do you know?—We are very fair in Penryn.

17470. About an average?—But we had a big outbreak a few years ago, due to a contaminated well; then we had some 90 odd cases in Penryn and the adjoining part of Budock parish. The well was in Budock.

17470*. But the last few years?—We are very healthy.

17471. What is your typhoid record in the autumn, about an average?—Perhaps we might go a year, two, or three years without a single case; oh, we are very well in Penryn for typhoid fever.

17472. And in Flushing?—In Flushing with a population of about 800 there have been, during the past eight years, about 20 cases of typhoid fever, whilst in the whole of the East Kerrier district, of which Flushing forms a part, there have been during the same period about 61 or 62 cases. Carclew is in the parish of Mylor, and so too is Flushing, but I am not including the Carclew cases, or any cases that may have occurred in Mylor, with the numbers I have given for Flushing.

17473. Have you persuaded the inhabitants of the district generally that the oyster is a cause of typhoid fever?—No, I have not; they do not believe it.

17474. In spite of your evidence?—Well, they do not confess it.

17475. Since there is no large consumption of oysters on the spot, most of your oysters, then, go elsewhere?—I should think they did.

17476. Do you know where they go to?—I do not know where they go to. I think they are sold, a great number, to a merchant there, a Mr. Dodd, and he sends them away—so I have been told. His wife only told me a day or two ago that they are sent away to some other place—I forget the name of the place—where they are laid down before they are sold.

17477. These are layings in the Penryn Creek of oysters ready for the market?—Oh, yes.

17478. They do not require laying down again?—They will sell them. Anyone coming there or wanting oysters can have them.

17479. Yes, but you said the consumption of oysters in the district is very small, and the production of oysters is very large. Where do they go to?—This merchant, Mr. Dodd, purchases a great quantity, and there is another merchant across the creek—Mr. Mead—who also takes oysters, but I do not know where they go to.

17480. There must be a considerable sale?—Yes.

17481. But you do not know where they go to?—I do not know where they go to.

17482. You only know that some are taken up, I suppose?—By a local man—Trounce he is called: he really supplies the neighbourhood, and has done so for years. He goes to different houses, such as Carclew and similar houses in the neighbourhood, for seven or eight miles around, and to the better class of people who purchase good fish and oysters.

17483. (*Chairman.*) Do you imagine the oysters come much to London?—I do not know. I could not give any evidence on that.

17484. (*Sir Michael Foster.*) You say this creek is a very good fattening creek?—Yes.

17485. I suppose the oysters are good oysters—oysters of a high reputation?—Yes.

17486. For the table?—Yes.

17487. (*Major-General Carey.*) Has any bacteriological analysis ever been made of the water in which the oysters have been laid for fattening purposes?—None that I know of. I believe that during the last inquiry a bacteriological expert came down and took samples.

17488. And the result?—But I do not know the result.

17488*. Your opinion that the enteric outbreaks have been due to the consumption of contaminated oysters is entirely an inference—circumstantial, not scientific, proof?—Not scientific proof, no.

17489. (*Mr. Stafford.*) What was the extent of these outbreaks—the one at Carclew and the one at Bodmin?—The number of cases?

17490. Yes?—There were six or seven at Carclew and there were two at Bodmin, and several cases also with symptoms of some irritant poison—ptomaine poison.

17491. So that the outbreaks really were of a very limited extent?—Of a very limited extent, yes.

17492. Is this creek a very narrow creek where the oysters are laid?—Yes, it runs up from the Falmouth harbour, being about a mile and a half in length, and from a couple of a hundred yards to half a mile in width.

17493. From what source does the pollution of this creek arise?—The pollution of the creek arises from three sources—from Penryn at the head, and from Flushing on one side and Falmouth on the other.

17494. And does the sewage of these towns discharge without being treated into this creek?—Yes. There is sewage coming from Green Bank at Falmouth direct straight away from the drain. At the Market Strand there is a sewage tank which simply, I believe—I cannot speak officially on this point—allows a settlement of the solids, these are cleaned out, and the overflow goes straight into the harbour. Then at Flushing, of course, the sewage goes, as I say, straight from the sewers, on to the foreshore, and also at Penryn as well.

17495. Have there been many cases of enteric fever, say, in the last 10 years in connection with the towns that discharge into that creek?—Independent of oyster eating?

17496. Oh, independent altogether?—Yes. At Falmouth some years ago—three or four years ago—there was a great epidemic of typhoid fever.

17497. So that there has been specific pollution of the creek?—Yes. I do not know whether it was not the same season—I think it was—or it was at the end of the epidemic—when these cases at Carclew occurred. The excreta from these Falmouth cases passed into the harbour.

17498. Do you think, then, that the oysters were specifically polluted before the outbreak at Falmouth?—No; I connected their being specifically polluted as being possibly caused by the outbreak at Falmouth. The outbreak at Falmouth was before the consumption of those oysters at Carclew.

17499. What was the extent of that outbreak at Falmouth?—I could not give the number—I am not certain. There was an inquiry for the Local Government Board by Dr. Buchanan.

17500. What year was that in?—May I just refer to the report I have?

17500*. Yes, certainly?—I have just said here in this report:—"With regard to why there were more cases in 1899 than in other years, it must be remembered that during the latter half of 1899 there was an epidemic of typhoid fever in Falmouth, and that for a considerable period sewage containing typhoid excreta must have been discharged into the harbour in considerable quantities." So that it was in the latter part of 1899.

17501. And your outbreak at Carclew and Bodmin?—The outbreak in Carclew was in November.

17502. Of the same year?—In November and December, yes. The latter part, just the very last day or so of November and the commencement of December.

17503. The Carclew and Bodmin outbreaks were to a very limited extent apparently?—Yes, yes; they were. The consumption of oysters, as I have said, in the neighbourhood is very occasional—not very general. I think some of the houses might have the oysters now and then, but the majority not at all.

17504. You have apparently connected them in your own mind—the outbreak at Falmouth with the limited outbreaks at Bodmin and Carclew—owing to the pollution of the oysters from the Falmouth sewer discharges?—No, I do not connect Falmouth with these outbreaks. The Falmouth outbreak had probably nothing to do with them, only in order to afford a possible explanation for the Carclew cases, I say that just prior to the appearance of these cases typhoid excreta in considerable quantities were discharged from Falmouth sewers into the same harbour from which the oysters, which, in my opinion, gave rise to the Carclew cases, were taken.

17505. No, I did not suggest that it had; but I suggested it had something to do with the specific pollution of the oysters?—I think it is possible, yes.

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17506. Owing to the outbreak at Falmouth, you had specifically polluted oysters at Bodmin and Carclew?—Yes, in my opinion it was. The oysters were exposed to sewage contamination, and it is possible for typhoid fever to arise at any time among those who consume such oysters. Year after year may go by without a single case of fever, and yet at any moment one or more may occur. I do not say that the Carclew cases were for certain the direct result of the presence of typhoid discharges in the Falmouth sewage, but, as I have said before, I think this affords a possible explanation for cases of enteric occurring more in that year of 1899 than in other years as the result of eating oysters taken from any such site as the oysters in question were taken from.

17507. If you had no discharge at all of sewage, or, furthermore, if you had no enteric fever in those particular towns, do you think you would have been likely to get an outbreak of enteric fever from eating those oysters? Suppose you had no specific pollution, and you had no enteric fever stools going into the sewage, would you have, do you think, enteric fever arising from eating the oysters, although they might be polluted by domestic sewage?—I do not know that I can give any special opinion on that point.

17508. (*Sir Michael Foster.*) Do you know what was exactly the laying from which the Carclew oysters came?—The man (Trounce) declared that these oysters were not Flushing oysters. In fact, in speaking of his oysters, he had before this said to me: "The oysters I sell are quite pure. I get them from Perceuil, near St. Mawes." But his custom was to buy these St. Mawes oysters, then to stock them in a box on the Flushing foreshore, there to remain until disposed of. So that, in my opinion, such oysters, wherever they came from, were converted practically into Flushing oysters.

17509. Pits placed close to the sewage outfall of Flushing?—Yes.

17510. Are you sure you had no typhoid fever in Flushing anterior to the outbreak at Carclew?—Yes; but I have attributed all the cases occurring in Flushing itself to the sanitary condition of Flushing, or insanitary condition.

17511. But you had cases of enteric fever in Flushing during the weeks preceding the outbreak of the attack at Carclew?—No; those 20 cases at Flushing, as I say, have been distributed over the past eight years.

17512. Are you sure there was no case of enteric fever at Flushing, say, for the two months previous?—If you will allow me, I will just refer; I do not think there was.

17513. Was every case notified?—Every case, as far as I know.

17514. As far as you know, you are not in a position to say that there was no enteric fever in Flushing; you cannot be positive there was no enteric fever in Flushing in, say, the two months anterior to the outbreak at Carclew?—Well, the medical men in the neighbourhood are always very strict about notifying their cases. I see there was one case in Flushing in January.

17515. When was the outbreak in Carclew?—In November and December.

17516. (*Mr. Power.*) And the outbreak in Falmouth, when was that, on the other side of the river?—The latter half of 1899—the same year.

17517. November being the date of the Carclew outbreak?—Yes.

17518. (*Sir Michael Foster.*) In Penryn; were there any cases in Penryn?—No, I do not think there were.

17519. Then you were singularly free from typhoid just preceding the outbreak at Carclew?—As I say, we have very few cases latterly in Penryn; we might have a case once—one or two, two or three cases—a year, but it is not a town in which typhoid is always present, by any means. I consider Penryn very healthy as regards typhoid fever.

17520. (*Chairman.*) I should like to ask you, in order to enable us to gauge the importance of the oyster industry in Penryn Creek; you can tell us the number of people employed in connection with it, roughly?—I could only go by the statement made at the Local Government Board inquiry—I was rather astounded at hearing it. About 2,000, I think, was the figure which was said would be affected; this number would, of course, include the wives and children of the oyster men, I could not give you the numbers for the whole neighbourhood.

17521. You suggest that several hundred men—fishermen—are engaged in that particular industry?—That is in Flushing and St. Mawes and the Truro river generally.

17522-6. I think you understand my question as to the number of people employed in the industry locally, and you told me that the number that had been mentioned was 2,000, but that that included all the persons indirectly affected, viz., the families of them?—Yes, I believe so; it could not be any other.

17527. I suggested to you that it might be hundreds, possibly some 300 or 400?—At the most, I should think.

17528. (*Sir Michael Foster.*) That is in Penryn Creek only, excluding Truro?—No, I think that would include Truro, the whole Falmouth Harbour, and St. Mawes.

17529. But Truro is much more extensive than Penryn?—Truro is a long way up—eight or nine miles up the river.

17530. (*Colonel Harding.*) But those layings are much more important, are they not? My questions referred simply to the Penryn Creek?—Referred to the Penryn Creek; then I should not think there would be 50.

17531. (*Sir Michael Foster.*) 50 men?—Yes, 50 men.

17532. (*Colonel Harding.*) Are fully engaged in it, or do they follow other occupations?—They follow other occupations at certain times of the year; some of these men go yachting, and then at other times of the year they go oyster dredging.

17533. So that they are not wholly employed in the industry?—Not fully employed.

17534. One may gather, therefore, that the stoppage of that industry would not be a very serious matter.

17535. (*Sir Michael Foster.*) The oyster industry is their main income, is it not; the yachting is, so to speak, their pocket money?—Yes, their main income.

17536. About 200 or 300 people together, which is, say, 50 men with a family of five; that would include 300?—Well, I can only speak very, very generally on that point, because I have nothing to do really with Flushing, except just officially.

Mr. A. Newsholme, Medical Officer of Health, Brighton, called; and Examined.

Mr. A. Newsholme.

17537. (*Chairman.*) You are Dr. Arthur Newsholme, and Medical Officer of Health for Brighton?—Yes, my Lord.

17538. We are very much obliged to you for the full and interesting statement that you have sent us in writing, and I would propose that that stands bodily at the head of your evidence?—Yes, my Lord.

I am Medical Officer of Health for Brighton. I began early in 1894 to suspect that oysters were frequently the cause of sporadic cases of typhoid fever in Brighton, which could not be traced to the ordinary sources of infection, such as contaminated water or milk; and on March 29th of that year I presented to the Sanitary Committee of the Brighton Town Council the report, of which a copy is appended, ascribing eight recent cases of typhoid fever to this cause.

On April 20th, 1894, I interviewed Mr. Power on the same subject, urging the necessity of pressure being brought by the Local Government Board on the responsible sanitary authorities to execute an efficient combined system of main sewerage.

In December, 1894, a deputation from the Committee had an interview with the representatives of the Local Government Board, and urged upon the Board the desirability of their obtaining statutory authority enabling them to control the sale of sewage-contaminated shell fish. The Parliamentary Secretary of the Local Government Board did not hold out any hope of anything being done in this direction, though he admitted that the Medical Department of the Board had evidence of mischief due to shell fish.

Particulars of steps in the same direction up to the present date are given on page 43 of my annual report for 1902.

I. The Extent to which Illness is Caused by the Consumption of Sewage-Contaminated Shell Fish.

The following table gives a statement of the number of cases of enteric fever, which, since 1894, have, in my opinion, been annually caused by oysters and other shell fish:—

Mr. A. Newsholme.

May 1903.

Year.	Number of Cases subsequently found not to be Enteric Fever, or of which the nature was doubtful.	Number of Cases of Enteric Fever, the infection of which was imported from other Districts.	Number of Cases apparently originating in the Town in which: (*a.*) It was stated that no Oyster or other Shell Fish had been eaten.	(*b.*) It was doubtful as to whether Shell Fish had been eaten.	(*c.*) Origin was directly ascribable to Oysters.	(*d.*) Origin was directly ascribable to other Shell Fish.	Infection probably acquired in connection with the storing or handling of Shell Fish.	Total Cases of Local Origin.
893 (from Midsummer)	1	16	19	6	6*	—	—	31
1894	15	15	33	1	16	5	—	55
1895	12	19	37	—	7†	12	—	56
1896	7 + 3	18	61	2	22‡	8	1	94
1897	7 + 3	15	47	11	11†	16	3	88
1898	16	15	54	3	28§	13	—	98
1899	15	30	56	20	44‖	8	—	128
1900	19	15	28	4	12¶	4	1	49
1901	6	7	15	9	6	3	—	33
1902	11	12	17	—	12	11	2	42

* No secondary cases.
† Including one secondary case.
‡ Including two secondary cases.
§ Including five secondary cases.
‖ Including seven secondary cases.
¶ Including one secondary case.

Other cases of illness, such as severe diarrhœa and vomiting, have not infrequently occurred among the friends of typhoid fever patients, who partook of oysters or other shell fish at the same time as the patients; but, as these attacks were not notifiable, only individual cases can be quoted.

The preceding table indicates that in 158 out of 674 cases of typhoid fever occurring in the years 1894-1902 inclusive, *i.e.*, 23·6 per cent. occurred among oyster-eaters who had eaten oysters within the period of incubation of this disease, and that 11·9 per cent. occurred among those who had eaten other shell fish within the period of incubation.

Diagram (A) shows the incidence, so far as can be ascertained, per 100,000 of population in 1894-1902 of cases due to oysters, to other shell fish, and other causes. The diagram includes only cases originating in Brighton.

The following table presents the same facts:—

TYPHOID FEVER.

——	Total cases of Typhoid Fever of local origin.	Cases ascribed to Oysters.	Cases ascribed to other Shell-fish.	Case rate per 100,000 of population.		
	(a.)	(b.)	(c.)	(a.)	(b.)	(c.)
1894	55	16	5	46·5	13·4	4·2
1895	56	7	12	47·0	5·9	10·1
1896	94	22	8	78·5	18·4	6·7
1897	88	11	16	73·0	9·1	13·3
1898	98	28	13	80·8	23·1	10·7
1899	128	44	8	104·9	36·0	6·5
1900	49	12	4	39·9	9·8	3·2
1901	33	6	3	26·7	4·8	2·4
1902	42	12	11	33·7	9·6	8·8

Measures Adopted to Protect the Public from this Danger.

In the Session of Parliament of 1896 the Council included in their local Bill a clause intended to prevent the sale within the borough of shell fish known to come from sewage-contaminated sources, in cases where the medical officer of health was of opinion that infectious disease was caused, or likely to be caused, by the consumption of such shell fish.

The clause was objected to by the Board of Trade on the ground that the powers, if granted, should be the subject of a public Act, and, after a hearing extending over two days, the Parliamentary Committee refused to grant the powers.

In 1897 the Council adopted a memorial to the Local Government Board praying for public legislation dealing with this question, and this memorial was also sealed by 27 of the 33 great towns, and by the London

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Port sanitary authority; and the London County Council also passed a resolution supporting the proposal.

On March 30th, 1898, the President of the Local Government Board received a deputation of the memorialists and gave them an assurance that legislation in the desired direction would be proposed.

In 1899 the Oysters Bill was introduced by the Local Government Board, and the Town Clerk of Brighton and myself gave evidence in support of it before the Lords' Committee. The Committee, however, amended the Bill by substituting the Local Fisheries Committees for the Local Sanitary Authorities as the authority for administering the provisions of the Bill, and the Local Government Board thereupon withdrew the Bill.

The Town Council of Brighton on February 19th, 1903, passed the following resolution:—

"Resolved: That in the opinion of this Council it is urgently necessary, in the interest of the public health, that legislation should be enacted by Parliament for the protection of the public against the danger to health arising from the consumption of oysters and other shell fish derived from sewage-polluted sources, and that the President of the Local Government Board be respectfully requested to introduce such a measure into the next Session of Parliament."

The councils of the municipalities of England have been asked to support this resolution.

The proper legal remedy, in my opinion, would be a combination of the Brighton Corporation Bill of 1896 and the Government's Oysters Bill of 1899.

The Government Bill did not extend to mussels and cockles. Shell fish, like mussels and cockles, which are not laid down in special beds, but may be gathered in various parts of the bed of an estuary, could not be controlled by its means. It is essential, in my opinion, that not only should sanitary authorities have control over oyster layings situate in their districts, but also that they should be able to prevent the sale within their districts of oysters and other mollusca derived from sewage-contaminated sources, or when they are able to show that these shell fish have caused cases of enteric fever, or other serious illness.

Pending the granting of these powers, the Brighton Corporation have issued posters containing the following warning:—

"County Borough of Brighton.

"The public are warned against eating oysters, mussels and cockles derived from sewage-polluted sources. Serious illness is frequently caused by neglect of this precaution.

"(Signed) Arthur Newsholme,
"Medical Officer of Health."

The Brighton Corporation have also passed a draft bye-law prohibiting the sale or exposure for sale in the Brighton Corporation Fish Market of oysters or other shell fish known to have come from a sewage-contaminated source.

"County Borough of Brighton.

"Bye-law made by the Mayor, Aldermen and Burgesses of the County Borough of Brighton for the prevention of the sale of unwholesome shell fish in the Borough Fish Market.

"1. A person resorting to the Market Place on the beach above high-water mark for the sale of fish shall not sell or expose for sale, or cause to be sold or exposed for sale, in the said Market Place, any oysters or other mollusca which have been obtained from any pond, laying pit, estuary, river, or other place polluted or contaminated with sewage.

"2. Every person who shall offend against the foregoing bye-law shall be liable to a penalty of £5. Provided, nevertheless, that the justices or court before whom any complaint may be made, or proceedings may be taken in respect of any such offence, may, if they think fit, adjudge the payment as a penalty of any sum less than the full amount of the penalty imposed by this bye-law.

"Given under the Common Seal of the said County Borough this day of , 1903."

This bye-law has been submitted to the Local Government Board, and the following letter has been received from the Board on the subjejct:—

Local Government Board,
Whitehall, S.W.
April 3rd, 1903.

Sir,

I am directed by the Local Government Board to advert to your letter of February 19th last, forwarding a draft of bye-laws proposed to be made by the Town Council of Brighton for the prevention of the sale or exposure for sale, in the Borough Fish Market, of oysters and other mollusca which have been obtained from polluted or contaminated sources.

The Board gather that the proposed bye-law is intended to be made under the general law, and they direct me to state that it seems to them that the bye-law goes further than is warranted by the terms of the last paragraph of Section 42 of the Markets and Fairs Clauses Act, 1847 (10 and 11 Vict., c. 14), which authorises the making of bye-laws for preventing the sale or exposure for sale of unwholesome provisions, and that any bye-law under that enactment should be restricted so as to cover only oysters or other provisions actually unwholesome without reference to their place of origin. Having regard, however, to Section 15 of the Act of 1847, which is incorporated with the Public Health Act, 1875, by Section 167, and to the stringent provisions of Sections 116 to 119 of the Act of 1875, the Board generally consider that bye-laws upon this subject will be found to be unnecessary.

I am, Sir,
Your obedient servant,
(Signed) H. C. Monro,
Assistant Secretary.

The Town Clerk,
Brighton.

To this letter the Town Clerk has transmitted the following answer:—

Town Hall, Brighton.
April 5th, 1903.

4423
22840 C 1903.

Sir,

Your letter of the 3rd inst. with reference to the draft bye-laws proposed to be made by the Council for the prevention of the sale or exposure for sale in the Borough Fish Market of oysters and other shell fish which have been obtained from sewage-polluted sources, has been submitted to my Committee, and in reply I am directed to make the following observations:—

The bye-laws in question are proposed to be made under Section 42 of the Markets and Fairs Clauses Act, 1847, which authorises the Corporation to make bye-laws for preventing the sale or exposure for sale of unwholesome oysters and other provisions in any market under their control. The Corporation have carefully considered the possibility of taking action by seizure under Section 15 of the Act of 1847, or Sections 116 to 119 of the Public Health Act, 1875, and are satisfied that the provisions above referred to do not provide a remedy for the mischief with which they are seeking to deal. The oysters the sale of which the Corporation are seeking power to prohibit present absolutely no naked eye evidence of unwholesomeness, although they are, judged, from past experience of other oysters from the same source, capable of causing fatal illness. Samples of such oysters, if examined bacteriologically, may or may not, owing to the necessary limitations of the method of examination, show evidence of sewage pollution, although the same is undoubtedly present in a considerable portion of such oysters. Moreover, the result of any such examination is only evidence in the case of the particular consignment from which a sample is taken, and there would be no means of dealing with future consignments from the same place except by repeating the same expensive and uncertain process.

My Committee are strongly of opinion that if it is proved that any particular oyster layings are seriously polluted by sewage, the oysters from such layings should not be permitted to be sold in the public market over which the Corporation have control. They, therefore, respectfully desire that the Board will, having regard to the great importance of the question, in the interests of public health, reconsider their decision not to sanction the bye-laws.

I am, Sir,
Your obedient servant.
(Signed) F. J. Tillstone,
Town Clerk.

The Assistant Secretary,
Local Government Board,
London, S.W.

The Board do not enlighten us as to how oysters or other shell fish which are capable of causing serious illness, judging by experience of other shell fish from the same source, can be determined to be unwholesome without reference to their place of origin.

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The evidence on which decision as to the wholesomeness of a given consignment of oysters or other shell fish is based must necessarily comprise the following items:—

(a) It is known that the shell fish in question are derived from beds or layings which a sanitary inspection has shown to be seriously contaminated by sewage.

(b) Samples of water in the immediate vicinity of shell fish in the layings in question show evidence of contamination by sewage.

(c) It is known that among the population whose sewage discharges so as to contaminate the shell fish in question enteric fever is endemic.

(d) The shell fish in question have been traced from the contaminated layings to the market.

(e) Shell fish coming from the same source can be shown by strong circumstantial evidence to have caused cases of typhoid fever, diarrhœa, etc.

To state, as is stated by implication in the letter from the Local Government Board, that Sections 116 to 119 of the Public Health Act, 1875, suffice for the protection of the public from sewage-contaminated shell fish, shows a lack of appreciation of the requirements of the case which is most unfortunate. These sections enable the medical officer of health or sanitary inspector to seize articles of food which are diseased, unsound, unwholesome, or unfit for the food of man. The oysters which the Corporation are by implication advised to seize under these sections present absolutely no naked-eye evidence of unwholesomeness, although they may (judging by past experience) be capable of causing fatal illness. If samples are bought and subjected to bacterioscopic examination, the rest of the consignment has been sold before the results of the examination can be obtained, and the result of the examination of such samples is not evidence in respect of any consignment of oysters from the same source, other than the consignment from which the samples were taken. These clauses, in fact, are entirely inoperative for this purpose. The Town Council are urging these considerations on the Local Government Board, and it is hoped that the Royal Commission will support their contention.

Methods of Determination of Contamination of Shell Fish and of Pollution of Layings, etc.

(1) The details of chemical and bacteriological examination of water from the polluted estuaries, and of bacteriological examination of the shell fish themselves, are matters for the chemist and bacteriologist. It is not necessary or desirable to trust to the evidence of these experts alone, though their evidence furnishes valuable confirmation of what may be determined by (1) sanitary inspection, and (2) experiments on human subjects.

(2) The sanitary inspection of the estuary where the shell fish are deposited would reveal serious sources of contamination. Obviously considerations as to flow of tides, distance of the source of contamination from the oyster layings or bed of mussels, etc., and the number of population whose sewage drains towards the polluted laying, would need to be taken into account.

(3) The most constantly valid evidence of contamination is furnished by the effects of the shell fish on those consuming them. If a larger incidence of typhoid fever occurs among oyster-eaters than among non-oyster-eaters, *e.g.*, if in individual families those eating contaminated shell fish are picked out for attack, if groups of cases occur among persons who have eaten shell fish at the same time, we obtain circumstantial evidence, which steadily gains in strength as the instances multiply.

17539. And now the members of the Commission will ask any questions that they like?—Yes.

17540. The only thing, I think, that I have got to ask you myself is, I do not quite understand whether your report of 1894 has already been published?—No, it has not been published, my Lord.

17541. There is no objection to publish it?—Certainly not—no objection at all.

17542. It might be published in your evidence before us, published with this statement?

(Copy.)
Health Department,
Town Hall, Brighton,
March 24th, 1894.

Special Report of an Outbreak of Enteric Fever, Apparently Caused by Eating Oysters.

To the Sanitary Committee of the
Brighton Town Council.

Gentlemen,—

During last year Brighton had, apart from the occurrence of a few sporadic and imported cases, a comparative immunity from typhoid fever. This immunity continued during the two first months of the present year, only two cases occurring during this period, of which one appeared to be imported from Cambridge, and the origin of the other was doubtful.

During the present month, however, this immunity has ceased, eight cases having been notified in seven houses since the 6th of March.

(1) The first of these cases, a male aged 33 years, living at No. 88, One Road, began to be ill on the 26th February. He was seen by me, at the request of the doctor in attendance, on the 6th of March, and removed to the sanatorium as a doubtful case of typhoid fever, the diagnosis being made certain by the subsequent course of the illness. The sanitary condition of this house was bad, there being an old brick drain which passed under the scullery, and a large dipstone trap at the back of the house, which was practically a cesspool. The upstairs water closet was out of repair, and the soil pipe (outside the house) defective. This patient had about Christmas a very severe sore throat, and at intervals since. His health has been very poor in this house, and during the month before the onset of his present illness he frequently had oysters from a neighbouring shop. These oysters were obtained by the fishmonger from Messrs. Chatfield, Southwick.

(2) On the 8th of March I received information of a case of typhoid fever, a girl aged 11 years, at No. 35, Two Street. There were five or six other children in this house belonging to two families. The drain was somewhat defective, but it is doubtful if this caused the attack.

(3) On the 18th I received information that the mother of this patient was ill with what was thought to be "influenza." I then wrote to the doctor in attendance, requesting his permission to see the patient with him. We saw the patient together on the 18th instant, and agreed that she was suffering from typhoid fever, and she was at once removed to the hospital. This patient and the daughter were in the habit of eating escallops. I cannot yet ascertain whether they have had oysters recently.*

(4) On the 20th, a boy, aged 13 years, at 38, Three Road, was notified as suffering from typhoid fever. There was a large family in the house, all of whom were ill, including the father and mother. The boy began to be ill on the 4th of March; for a week after this he kept at work. I was asked by his doctor to see him on the 20th of March, and on the same day he was removed to the fever hospital. The boy was employed, prior to his illness, as errand boy at a fishmonger's shop in Preston Street. He distinctly remembers that about 17 or 18 days before the onset of his illness (*i.e.*, about the 14th February), the foreman at the shop gave him three oysters. This is the only occasion on which he has had oysters given to him. The oysters came to the shop from Messrs. Chatfield's ponds at Southwick.

(5) On the 26th instant, I was informed that a girl, aged 13 years, at 13, Four Road, was suffering from typhoid fever. She began to be ill on the 14th of March. Both she and her mother, who lodges with her in the same house, are very fond of oysters, and have them at least twice a week. They buy oysters from a man who calls at the house. This man called as recently as Good Friday (March 23rd) to say that he regretted he could not bring any oysters that day, as, being holiday time, "the man had not brought them in from Southwick." The house in which this patient lives was redrained three years ago, and appears to be in a completely sanitary condition. The mother of this patient suffered from severe diarrhœa during the week ending March 24th, but when seen by Dr. Chaffey on the 26th inst. her temperature was normal.

(6) On the 28th inst. I received information that a man, aged 37 years, living at No. 2, Five Street, was suffering from typhoid fever. He began to be ill on the 17th March. He is an invalid attendant, and returned from Havant about a month before that time, where he

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* This was subsequently found to be the case.

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had been nursing a dipsomaniac patient. On the 28th of February he bought from a barrow in the street 15 oysters. He asked his wife to join in eating them, but she declined. He therefore ate seven on that day, and eight two days later. The source of these particular oysters is unknown. The house in which the patient lives appears to be in a good sanitary condition.

(7) On the 15th inst. I was informed that a woman, aged 35, living at No. 56, Six Street, was suffering from typhoid fever. The husband is a caterer. The house in which the patient lives is modern. I have been unable as yet to ascertain whether she partook of oysters before her illness, but the nurse in charge of her informs me that she is very fond of oysters, and is begging for them at the present time.

(8) On the 28th the case of a lady, aged 48 years, living at No. 5, Seven Street, was notified to me as typhoid fever. She began to be ill on the 14th instant, and, on the 5th instant, partook of oysters, which were obtained from a neighbouring tradesman.

A careful investigation has been made of all the circumstances likely to throw light on the origin of these eight cases. No two cases had a common milk supply. The water supply was above suspicion. The sanitary conditions of two or three houses were defective; but they do not, in my opinion, explain the origin of the majority of the cases, if of any. The one point in common appears to be that five out of the eight patients have taken oysters at such a date before the commencement of their illness, as was consistent with the view that the oysters caused this illness. Of the remaining three, two had partaken of escallops, and, possibly, of oysters, though I am as yet unable to speak positively on this point. The remaining patient is the wife of the caterer, and is fond of oysters, though there is no evidence of her having had any within a month of the onset of her illness.

The oysters in three of the above cases were obtained of Southwick. The oysters in two other instances were of these three shops were supplied by Messrs. Chatfield, of Southwick. The oysters in two other instances were bought in the street, and it is known in one of these that the oysters came from Southwick. In the other instances there is, however, little or no doubt that the oysters in question came from Southwick. With a few exceptions, the whole of Brighton is supplied with oysters by two merchants, Messrs. Chatfield and Messrs. Brazier Bros., whose oyster beds are at Southwick, close to each other. It is only very large fishmongers who have such a sale for oysters as will justify them in having casks of oysters from Billingsgate, or other centres. For the majority, or small tradesmen, it is a great convenience to have small supplies at frequent intervals from a local depôt. The two firms above-named are the only oyster merchants who thus supply Brighton. It thus became a matter of great importance to ascertain the conditions under which these oysters are grown at Southwick.

I therefore visited the market ponds of these firms yesterday. They are situated on the north side of the River Adur, just below the lock. By means of stakes and stones ponds are formed, and in these oysters are placed for a few days before being taken to Brighton for sale. The position of the ponds is shown in the accompanying map. They are probably about 150 yards below the point at which the Southwick sewage empties on to a neighbouring mud bank, and on the same side of the central stream. At the time of my visit a black stream of sewage was trickling down this mud bank, and rats were disporting themselves on its margin. The smell was most offensive. The oyster ponds at my visit were uncovered except by a small quantity of water imprisoned by the boundary walls of the ponds. The oysters lie loose in these ponds on a bed of mud. Twice a day the ponds are covered by the tide, and water, pure or impure, as the case may be, is washed into them.

The oysters are brought from the French coast and grown in the South Gut or stream shown on the map. A few days before they are required they are brought to the ponds described, just below the outfall of the Southwick sewage.

Assuming, as I believe to be the case, that the oysters from these ponds caused the above-named cases of typhoid fever, it is additional proof of the urgency for a reorganisation of the method of sewage disposal of the district in question.

It may be asked why, if the oysters were the cause of these cases of typhoid fever, a larger number of cases have not occurred, as the number of oysters brought from these ponds to Brighton is enormous. I am unable to answer this question, but may point out that it is quite likely that out of a large number of oysters only a small number would swallow the specific poison of typhoid fever, and thus become the carriers of it to those who swallow oysters.

I have been unable as yet to ascertain whether any cases of typhoid fever have recently occurred at Southwick, but, even if this is not so, I can imagine no better means of preserving the vitality and causing the multiplication of any typhoid fever germs that even a year ago entered this channel and became deposited on the mud.

It will be a serious question for the Sanitary Committee to consider whether the facts of this report should or should not be made public. I have no power to seize oysters simply because they may be derived from a sewage-sodden mud bank. I know of no other means of preventing the use of these oysters except publicity.

If the Committee decide not at the present time to make the contents of this report public it is possible that pressure might be brought to bear on Messrs. Chatfield and Brazier to move their oyster ponds to a more sanitary position.

I am, Gentlemen,
Your obedient Servant,
(Signed) ARTHUR NEWSHOLME,
Medical Officer of Health.

TABULAR STATEMENT as to cases named in Preceding Report.

Age and sex of Patient.	Address.	Approximate date of onset.	Date notification received.	Date on which oysters were eaten.	Milk supply.	Sanitary conditions of house.
Male, 33 years	88, One Road	February 26	March 6	frequently	—	defective.
Female, 11 ,,	35, Two Street	—	March 8	doubtful; escallops eaten	Hillman	minor defects.
Female, 35 ,,	do. do.	March 10	March 18	do. do.	do.	do. do.
Male, 13 ,,	38, Three Road	March 4	March 20	February 14	Condensed	—
Female, 13 ,,	14, Four Road	March 14	March 26	frequently	Brooks	excellent.
Male, 35 ,,	2, Five Street	March 17	March 28	February 28	King	—
Female, 35 ,,	56, Six Street	March 1	March 15	doubtful, if any.	Hillman	—
Female, 48 ,,	5, Seven Street	March 14	March 28	March 5	—	—

17543. (*Sir Michael Foster.*) There is just one point I do not understand quite in the third page of your memorandum; a preceding table indicates that in 158 out of 674 cases of typhoid fever 23·6 per cent. occurred among oyster eaters?—Yes, sir.

17544. That is 23·6 per cent. of the 158, is it?—No, sir; 23·6 per cent. of the total number.

17545. Of the total number?—Yes, of the total.

17546. What is the point of 158 out of 674?—You will find that that works out 23·6 per cent.

17547. Oh, I see, quite so. Then I gather from the methods of determination of contamination of shell fish and pollution of layings, etc., that in your opinion the mere bacteriological examination of the oysters or lay-

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ings is not adequate proof?—No, I should not depend upon any one method of proof any more than I would depend in the diagnosis of disease on any one symptom. I should inquire as to the aggregate of the symptoms, and from them make my diagnosis, so here I should not depend upon any one proof of contamination.

17548. That is to say, there would be the bacteriological examination of the oysters and their layings?—Yes.

17549. There would be the topographical evidence, so to speak, that the sewage had contact with the beds?—Yes.

17550. And therefore probably was the cause of the bacterial pollution existing there?—Yes.

17551. And then the other evidence that those oysters did produce the disease?—Yes.

17552. I do not quite understand; you speak of sanitary inspection and experiments on human subjects?—I mean the involuntary experiments have been so extensive that they amount to experiments, I think, of considerable value.

17553. Then I take it that you certainly would refuse to condemn a laying simply on bacteriological examination alone, unless the results of the bacteriological examination were supported by other evidence?—I should require evidence that mischief had been done, and evidence that the supposed sewage organisms were caused by sewage coming into that particular estuary.

17554. (*Mr. Power.*) Would you test the water over the beds as well as the oysters in them?—Yes, that I mentioned in my proof.

17555. (*Sir Michael Foster.*) Put it in this way, in certain layings a certain number of oysters are found to contain, say, the true bacillus coli?—Yes.

17556. Well, that fact by itself in your mind is insufficient?—I am not a bacteriologist, and cannot speak on that point; but as a matter of fact I should never think of attempting to satisfy a court which had to determine this point on that one evidence alone; I should be prepared to give all the evidence of which I was possessed.

17557. I mean you would not expect any court to be satisfied with the evidence alone unless it was supported by topographical evidence, and subsequently by clinical evidence?—I think it is highly improbable that they would be satisfied, and I should not be surprised if they were not.

17558. I mean you yourself would not put it forward?—Alone?

17559. (*Mr. Power.*) But would you always wait for the clinical evidence?

17560. (*Sir Michael Foster.*) I was rather putting forward the topographical evidence?—Yes. Before answering that question, there are three kinds of evidence—there is the topographical, the clinical, and thirdly the chemical; the bacteriological would make four of them, if you like. Having got two of them on the spot, those two alone I should probably not be satisfied with, but if I had clinical in addition to the topographical, chemical and bacteriological evidence, then I think I should have a complete case to act upon.

17561. In some of your cases I see there were distinct insanitary conditions in the houses?—That is so.

17562. I see you make the remark?—No. 1 case on page 1 of my addendum to my evidence.

17563. And also in another case, was there not?—Yes, in a good many cases altogether.

17564. You say broadly that you have excluded those insanitary conditions as being the possible cause of the disease; you state it very broadly, but I suppose you have gone very carefully into it?—I have gone very carefully into the circumstances, and, speaking generally, I have excluded the insanitary condition of the drains of houses as a frequent cause of typhoid fever; I do not believe it is.

17565. Quite so; you mean bad cases, and so on?—I think typhoid fever is chiefly swallowed.

17566. Quite so, but I mean the insanitary condition of the house frequently means, does it not, opportunities for swallowing?—It might do so; supposing the water supply were wrong.

17567. I mean a leaking drain; for instance, there is a leaking drain in No. 1?—Yes.

17568. It might open a path for the germ which would not exist if there were not a leaking drain?—Quite so; in all these cases the insanitary conditions of the house as a cause of typhoid fever were excluded by collateral evidence of absence of illness among other members of the same family, especially the younger members; in all these cases, or nearly all, it was the adult members that were affected.

17569. So your broad statement there represents a considerable quantity of investigation?—In every case every investigation was made, every possible circumstance was gone into in detail, and excluded so far as evidence was available.

17570. (*Mr. Power.*) But in all the cases referred to oysters, the possible operation of one other competent cause has always been considered?—In every instance; a case of typhoid fever was only put down to oysters after the apparent exclusion of every other possible cause.

17571. From that point of view, the data you give here would be for Brighton about the minimum amount of typhoid fever which is caused by shell fish?—I think the mischief is considerably understated in those figures, because in a very considerable proportion of cases it has been impossible, owing to the death of the patient or the removal of the patient, to get the full facts out, and then we had to leave those cases out in the percentage statement.

17572. (*Sir Michael Foster.*) I gather from your memorandum—I do not think it is distinctly stated so—that you are distinctly in favour of prevention by legislation of the consumption of oysters and other shell fish save from sources known to be free from contamination?—I think it is most urgently called for, and that the present means of remedying the mischief are insufficient. The Corporation of Brighton have been making strenuous efforts since 1894, and we have done very little good owing to the difficulties of co-operation between different authorities, and owing to the fact that the legislation promised has not been given.

17573. Do you think that if there were some large sanitary authorities so as to obviate the evil influence of local feeling or of individual power; if there were very large sanitary authorities the power might be given to those sanitary authorities with adequate expert equipment to determine whether such laying of oysters was free from contamination?—The larger the total authority for this purpose the better, but so far as the County Council is concerned—which was the local authority suggested in the Oysters Bill—that is a weak point; I am sure that the power of making the order which was suggested under the Bill will usually be in the hands of the council in whose district the insanitary oyster layings are situate, while the injury caused by the consumption of oysters from these layings will mostly arise in large towns outside the area represented by the County Council. For instance, the chief mischief about the Southwick oysters, in which I am specially interested, occurs in Brighton and Hove—Brighton is outside the jurisdiction of the area of the East Sussex County Council. I speak now, of course, from the point of view of a large county borough.

17574. But a large area which included county boroughs in the county, would you think that a proper authority for determining that might arise?—I should think it would.

17575. With a power of appeal possibly to some central board or to the Local Government Board?—With the power of appeal to a central board and power of appeal to that board to set the power in operation if they were not set in operation by the local authority. The great difficulty has been hitherto that it is nobody's business to make local authorities do their duty.

17576. But you think that in those circumstances really a great deal of the present evil, and still more—what is perhaps more injurious still—the present scare, might be avoided?—I think probably it would. In case I am not asked on the point I should like also to say that if the legislation is confined to oysters it only obviates a portion of the evil, and leaves untouched a very important large portion.

17577. Of cockles, periwinkles, mussels?—Mussels particularly.

17578. Has illness through mussels been particularly brought before your notice?—Very largely. I have given a statement of the relative amounts due to mussels and oysters. I think two-thirds roughly is due to oysters, and one-third to mussels, and other shell fish.

17579. The latter chiefly occur among the lower classes.

17580. (*Mr. Power.*) Are the mussels consumed in Brighton brought mainly from the neighbouring coast or from further afield?—Mainly from the neighbouring coast; some from Newhaven—which is frightfully polluted—and the majority from Shoreham and Southwick, and with regard to the mussels, may I add that the difficulty of acting by purifying the layings is very much greater than in regard to oysters, and it appears to me that it is extremely important that large local authorities, like the county borough of Brighton, should have power to prevent the sale within their jurisdiction of mussels which they can prove have caused mischief in the past, and which they can prove are derived from places polluted by sewage. The mere giving power to large local authorities to control these layings would not meet the Brighton case. We require furthermore the power to prevent the sale in a given town of oysters or mussels which are polluted.

17581. (*Sir Michael Foster.*) But supposing the legislation took this form, that the large sanitary authority recognising, at all events for a limited period, certain layings or certain beds of oysters, mussels, and so on as free from suspicion, and registered them as free from suspicion, and there was a general law forbidding the consumption outside those registered areas that would meet your views?—Undoubtedly, if there was a general prohibition of the sale of oysters and other shell fish from other places.

17582-3. From all except the registered places?—From all except the registered places. That, I take it, would meet the case, assuming that the registration was properly carried out.

17584. Of course, it would want continual inspection with regard to it, you know?—Yes.

17585. Because the circumstances might change within a very small range of time?—Yes.

17586. (*Chairman.*) Do you mean that a town council may have a power to prevent the sale of any suspected shell fish within their dominions?—No, I should not go so far as to forbid the sale of suspected shell fish. One ought to use a much stronger word than that. Shell fish would have been proved to cause mischief, and the shell fish in question would have been proved to come from grossly polluted layings.

17587. Have the Brighton authorities made any attempt to get the particular shell fish condemned?—When we first of all waited upon the Local Government Board by deputation in 1894, Sir Hugh Owen advised the deputation to take that procedure. At the time I objected to that advice, and asked Sir Hugh how we were to prove that the particular oysters which we wished to seize were injurious to health or unfit for human food, because to the naked eye they were apparently quite normal. He said that probably we should not succeed, but, at any rate, we should do some good by the publicity. On the strength of that, we went back to Brighton, and we took counsel's opinion upon it. The counsel's opinion was adverse to proceeding under the Seizure Section of the Public Health Act. We were advised that it would be risky for us to do so, and, I think also, that we might lay ourselves open to further action. There can be no doubt at all that those clauses are not operative so far as this particular purpose is concerned. The oysters look perfectly normal, quite apart from a knowledge of the source from which they come, and quite apart from a knowledge of what they have done. It would be impossible to say from naked eye appearances that they were not fit for food.

17588. (*Mr. Power.*) The clauses of your Bill of 1896 referred only to oysters I suppose, did they?—I have the clause here which speaks of shell fish generally. Here is a copy of the clause:—

BRIGHTON IMPROVEMENTS, 1896.

New Clause 33, page 23.

In case the Medical Officer of Health is in possession of evidence that any person in the borough is suffering from infectious disease attributable to the consumption of shell fish supplied within the borough from any pond, river, or other place situate within or without the borough in which shell fish are commonly kept, bred, or cultivated, and in which pond, river, or place such shell fish have been, or are liable to be, exposed to contamination by sewage, or that the consumption of shell fish from such pond, river, or place is likely to cause infectious disease to any person residing in the borough, such medical officer shall, if authorised in that behalf by an order of a justice having jurisdiction in the locality in which such pond, river, or place is situate, have power to inspect such pond, river, or place, and all shell fish, matters, and things therein, and if on such inspection the Medical Officer of Health is of opinion that the infectious disease is, or is likely to be, caused by the consumption of shell fish supplied from such pond, river, or place, he shall report thereon to the Corporation or to the Sanitary Committee of the Council and the Corporation, or the Sanitary Committee, as the case may be, may thereupon give notice to the person by whom such shell fish is so kept, bred, or cultivated, to appear before them within such time, not being less than 24 hours, as shall be specified in the notice to show cause why an order should not be made prohibiting the supply within the borough of any shell fish from such pond, river, or place until such order has been withdrawn by the Corporation or the Sanitary Committee, as the case may be, and if in the opinion of the Corporation or the Sanitary Committee, as the case may be, such person fails to show such cause, then the Corporation or such committee, as the case may be, may make such order as aforesaid, and the Corporation or such committee, as the case may be, shall forthwith give notice of the fact to the sanitary authority and County Council (if any) of the district or county in which such pond, river, or place is situate, and also to the Local Government Board. An order made by the Corporation or such committee as aforesaid, in pursuance of this section, shall be forthwith withdrawn on the Corporation or such committee, as the case may be, or the Medical Officer of Health being satisfied that the cause of the infection has been removed. Any person refusing to permit the Medical Officer of Health, on the production of such order as aforesaid, to inspect any such pond, river, or place, or after any such order prohibiting the supply of shell fish as aforesaid has been given, supplying within the borough any shell fish from such pond, river, or place, in contravention of such order, or selling it for consumption in the borough, shall be liable to a penalty not exceeding £5, and to a daily penalty not exceeding 40s.; provided always that proceeding in respect of such offence shall be taken before the justices of the peace having jurisdiction in the locality where the said pond, river, or place is situate; provided that no person on whom an order prohibiting the supply of such shell fish has been made by the Corporation or such committee as aforesaid, shall be liable to an action for breach of contract, if the breach be due to such order. Every person who shall wilfully obstruct such medical officer or other officer of the Corporation assisting him in the exercise of the powers of this section, shall be liable for each offence to a penalty not exceeding £5.

17589. If you had obtained the powers you then sought, looking back now on further experience, do you think they would have been adequate for what you wanted to effect at Brighton?—Amply adequate; they would have done exactly what we wished them to do.

17590. That is to say, it would have kept out shell fish from particular layings and particular quarters of the foreshore until you, I suppose, as representing the Corporation, were satisfied that the shell fish in those positions were no longer exposed to risk? You did not intend to exclude them indefinitely, did you, from the particular localities?—What we wanted was an order prohibiting the supply within the borough "of any shell fish from such pond, river, or place, until such order has been withdrawn" by the Corporation or the Sanitary Committee, as the case may be.

17591. You designate the place. I suppose it would be left to the Medical Officer of Health, would it not, to advise as to the locality to be prohibited?—There is a hearing provided before an authority here, and we should have to give our evidence before that authority, and I think an appeal is subsequently given. The proceedings are taken before a justice of the peace, and I am under the impression that an appeal was provided subsequently to that.

17592. (*Sir Michael Foster.*) An appeal to——?—An appeal to the Quarter Sessions; but I am sorry I am not conversant with that point.

17593. (*Mr. Power.*) The justices of the area in which the layings were situated, I suppose?—Yes, the area in which the layings were situated. If we had had these powers during the last five years there is no doubt we

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should have been in a very much better position as regards typhoid fever than we are at present. So far as our own case was concerned it would have met our needs.

17594. Then failing that, you proposed certain bye-laws recently to the Local Government Board. How were you proposing to work these? You are not, I suppose, relying upon seizing shell fish in any large amounts and condemning it, so much as preventing despatch to Brighton from certain quarters?—I should explain that these bye-laws were proposed in consequence of the action of the Corporation of London; the market people there appear to have very exceptional powers. As a matter of fact, only a portion of the oysters and other shell fish supplied to Brighton come through its Corporation market. The larger proportion never go into the market, so this would only be meeting the case of shell fish which is brought into our own market and under our own control, and we thought it a highly improper thing that we should allow to be sold from the Corporation market shell fish which we knew in other parts of the town were doing mischief; hence we asked for this bye-law, and we object very strongly to the letter from the Local Government Board, which makes statements which, in our opinion, are the reverse of correct, that we have sufficient power now. We cannot help feeling that the Local Government Board do not realise the actual facts of the case.

17595. Under the bye law I suppose you would propose to prohibit the entry of oysters from particular layings until you were satisfied that they were no longer exposed to pollution?—Yes.

17596. You were not thinking of seizing shell fish on any large scale, were you?—No, sir, simply to prevent the sale, or exposure for sale, of unwholesome oysters in the market under the control of the Corporation.

17597. That is to say these people might sell their shell fish elsewhere than in Brighton, when they cannot sell them in Brighton?—It is simply for our own protection, as our own Bill in 1896 was.

17598. You did not propose to interfere with their trade, except so far as it affected Brighton?—That is so, sir.

17599. (*Mr. Stafford.*) Where do you say that the oysters come from that are sold in Brighton?—Most of them from Southwick, some of them from Emsworth, and one or two shops are supplied from Whitstable and Colchester.

17600. From Whitstable and Colchester?—Yes, the trouble has arisen with the two first.

17601. Do you know to what extent enteric fever has prevailed in these towns from which you derive your oyster supply?—I went very carefully into that question at the time we were promoting our Bill. Shoreham, Southwick, and Portslade—the population of that district is about 13,000 altogether, and cases of typhoid occur in it at frequent intervals; it is an unsanitary district as a whole, and there are a considerable number of cases of typhoid fever. In 1894, when I worked out the relation, I was able to show that at the time when the oysters were producing typhoid fever in Brighton there were at corresponding dates cases of typhoid fever discharging their sewage into places where the sewage could reach these oysters. I have here a tabulated statement, in a paper which I read at the Sanitary Institute in 1896, dealing with that.

17602. Were you able to localise the particular oysters that were doing the most harm in Brighton?—There was no difficulty in the majority of instances in discovering where the oyster came from. Occasionally the vendor insisted that they came from Whitstable and other places, but by watching the carts coming to the shops one had no difficulty, as a rule, in finding that they really came from Southwick.

17603. I see, and the Southwick oyster, you think, is not beyond suspicion?—That is a very mild way of putting it, sir.

17604. What is the population of Brighton?—The population of Brighton alone—124,000 approximately.

17605. How did you stand formerly with regard to enteric fever in Brighton?—I have here a diagram showing the amount for a series of years; that is, from 1894 onwards; that is the curve of the case rate since notification—the number of cases per 100,000 population since 1894.

17606. Was 1894 the year the Notification Act came into force in Brighton?—No. It was adopted in 1891, but my attention was not drawn to the causation of enteric fever from oysters until early in 1894.

17607. You have, I suppose, no accurate record before that?—No accurate record of cases. We have records of death, and I have here the record of the death rate for many previous years.

17608. Enteric fever is not unusually prevalent at Brighton?—No; we have less than in London, but the curves of the two populations run very close to each other.

17609. With regard to your first table, to column "C," "Origin was directly ascribable to oysters"?—Yes.

17610. I would like you to explain to us the principles as to how you arrived at all these cases being directly ascribable to oysters?—The evidence was circumstantial. In the first place it was known that the patient himself had eaten oysters within the limits of periods of incubation of typhoid fever.

17611. But you would not regard that as absolute evidence of the disease being due to oysters?—No, I should not. In the second place it was known that in the majority of instances the other members of the family who remained well had not eaten oysters. In the third place, these oysters were traced to particular layings which were proved to be exposed to sewage, and in the fourth place typhoid fever was found to exist amongst the population whose sewage was draining in the vicinity of these oysters. That was the chain of evidence which satisfied me, and it became more and more convincing as it accumulated. One cannot conceive of the force of the evidence until one goes closely into every individual case—case after case when the evidence becomes simply overwhelming.

17612. (*Sir Michael Foster.*) Were you able in those cases to exclude other possible causes of the typhoid fever?—In the majority of instances, with the exception which you have already asked me about, occasional bad drains in houses, but in every instance we could positively and certainly exclude water and milk, which are the two most common causes of typhoid fever, and the only other possibility, so far as we could ascertain by the most careful investigation, was the sanitary condition of houses; in the majority of instances that was excluded; the houses were perfectly sanitary. The only weakness, I may add, to be perfectly fair, as to the evidence, was that in a certain proportion of the cases, others who ate oysters did not get typhoid, but that did not prevent me ascribing the illness in the typhoid cases themselves to the oysters.

17613. (*Mr. Stafford.*) You do not think that the proportion of one quarter of the whole of the cases, which it practically amounts to here, is too large a proportion to ascribe to the eating of shell fish?—No, thereon may be based a statistical argument. It is certain that not nearly one quarter of the population eat oysters. More than one-fourth of the population is children, who do not eat oysters. If one assumed that one-twentieth part of the population eat oysters. Then you have five times as many cases of typhoid fever among the oyster eaters as among the non-oyster eaters in proportion 2to population. Furthermore, oyster eating is not a regular habit. People did not eat oysters every fortnight, consequently a large proportion of the population, which I have assumed to eat oysters, have not eaten them during the incubation period; therefore the disproportion of cases ascribed to oysters is much greater than appears on the surface; that is to say, that there would probably be 40 or 50 times as many cases of typhoid fever among the oyster eating population in proportion to population as among the non-oyster eating population.

17614. Before 1894 what are these cases ascribed to?—A large proportion of them were not traced, and we had every year the unsatisfactory experience of not being able to detect what individual cases were due to.

17615. Were they put down to unsanitary surroundings?—Very often they occurred where there were no unsanitary surroundings, or occasionally where there was a bad drain, as in the case mentioned by Sir Michael Foster. At that time we laid more stress on the bad drain than we do now, but I think everyone is agreed now that too much stress has been laid in the past on defective drains as a cause of typhoid fever.

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17616. But will you not always find in every outbreak of typhoid fever in the administration of every town, that there would be a very large number of cases that you cannot ascribe to a particular cause?—Our experience in Brighton has been that the more one goes thoroughly into each individual case the smaller the proportion due to unknown causes becomes, especially since we have begun the system of interviewing the patients after they get well. Very commonly you cannot find out the cause of typhoid fever until the patient himself has been able to be questioned and cross-questioned, and that system we have adopted very largely in Brighton.

17617. Are some of those 158 cases ascribed by you to oysters, due to one of these patients having enteric fever, and possibly infecting the others?—No, except that you will notice I give in the table the exact number of secondary cases, those infected from oyster cases, in a footnote.

17618. I do, yes?—The exact number is given there.

17619. The precise number of secondary cases?—Yes, sir; the first case is the oyster case; if another case occurred in the same house three weeks or a fortnight later that is a secondary case.

17620. You include those as due to oysters?—I have stated the exact number of them in each instance, and that was the system of tabulation which was adopted.

17621. With regard to the bye laws, do you still consider that you have got power to make bye laws to deal with this question?—The question of power to make bye laws does not seem to be disputed, I believe, in the letter of the Local Government Board. They are unwilling to give us the bye law, but I do not gather that they say there is no power to make such bye laws.

17622. I do not gather that quite from the letter of the Local Government Board. I thought they rather doubted your power to make effective bye-laws. If you have power to make effective bye-laws, why promote a Bill in Parliament?—I find they say the bye-law goes further than is warranted by the terms of the last paragraph of Section 42 of the Markets and Fairs Clauses Act. Then they go on to say that bye-laws on this subject will be found to be unnecessary. We maintain that bye-laws do not go further than that section, and that bye-laws are necessary.

17623. Are you advised to that effect?—We are advised to that effect by our legal adviser.

17624. That you have got full power to deal with this matter?—We are advised by our legal adviser that we have power, and we have written to the Local Government Board urging them to reconsider the matter.

17625. But why did you promote a Bill in Parliament then, in 1894, to deal with this matter?—Because the bye-law only covers a portion of the evil. It only proposes to deal with this actual exposing for sale in our own market. As I have already explained, the larger portion of the oysters never come into our market; they would not be met by this bye-law. We were simply straining every effort, wishing to have every means available, and this would have covered our moral responsibility so far as our market is concerned in allowing to be distributed from our market oysters which, in our opinion, were the cause of much mischief.

17626. But you did not propose by your Act of Parliament to deal with them outside your own district, did you?—No, sir, but I have not yet made it quite clear that not all the oysters that come into our district go through our market. A large number come direct from Southwick in the Southwick carts, and go straight to the retail shops.

17627. I see, you could not deal with that by a bye-law, could you?—No, sir, I think not.

17628. (*Sir Michael Foster.*) Have you any idea what proportion of the inhabitants of Brighton eat raw oysters on and off in the season?—I think any estimate would be a very, very rough estimate. If one worked it out on the supposition of 10 per cent., then I think that would be very excessive.

17629. 10 per cent. of the residents?—Yes.

17630. Or 10 per cent. of your population?—I do not know; it is a mere rough estimate.

17631. About 10 per cent.?—I would not like to say 10 per cent.

17632. (*Mr. Power.*) Is this oysters or shell fish?—I mean all shell fish.

17633. (*Sir Michael Foster.*) Would that include other shell fish?—Mussels, yes; I would not like to be committed to that figure at all; it is impossible to arrive at any estimate which would be satisfactory.

17634. There are two ladies there, are there not, who drive a very thriving trade in Brighton?—That is so, and they are the only people who have not had any typhoid fever among their customers.

17635. They sell chiefly to visitors, I suppose?—No, I am sorry to say they do not; they sell chiefly to well-to-do residents, who know their way about, and who know where to get good oysters. The visitors—we get frequent complaints from London and elsewhere of typhoid fever after they get home.

17636. We had yesterday evidence from Dr. Nash giving, say, about 5 per cent. of the population as eating oysters. That was in the case of Southend. Do you think that rather low?—No, I should think it is not low—10 per cent. is almost certainly excessive, I should think. I do not think a 5 per cent. figure, so far as I know, can be depended upon.

17637. We had a statement that 75 per cent. of the total population of the United Kingdom eat oysters at one time or another.

17638. (*Mr. Power.*) In their lives?—

17639. (*Sir Michael Foster.*) Per year?—I think that that does not make sufficient allowance for the number certain individuals will eat. They have no doubt taken the total consumption and divided it by the population, which is a very misleading way to get at it.

17640. (*Dr. Burn Russell.*) In your table there is a defect on the last two lines, 1901-1902, in the copy I have of your evidence; the first four columns are blank?—Oh, I am sorry.

17641. So that you cannot get the totals?—It can be got at, but I am sorry that I supplied incomplete copies. I did not notice that. It means that 17 cases ought to come into columns A and B.

17642. You will complete it?—I will complete it. Thank you; I am much obliged to you for drawing my attention to it.

17643. Have you gone into the age incidence in these cases?—I did at the same time as I went into the question of distribution of typhoid fever generally in this printed paper to which I have referred. Taking the three years 1894, 1895, 1896, it came out in this way: 61·1 per cent. of the cases amongst shell fish consumers were in adults over 20, and in cases in which no history of eating shell fish could be obtained it was 54·2 per cent. over 20.

17644. That is obviously a very interesting point. My experience of milk epidemics of enteric fever is that the incidence is very generally with children?—Yes.

17645. Milk epidemics of scarlet fever, that it is largely among adults?—Yes.

17646. So that it would be a very interesting point in your proof to develop this question of the age incidence?—Yes, I can go into that more fully if the Commission wish it.

17647. I think it would be very useful if you added something dealing with that, because it is certainly very important as matter of evidence?—Enteric fever generally is more common, whether among shell fish consumers or others, among grown-up people than among children; still, there would probably be a difference. I have not worked it out since 1896.

17648. But do you not think that there is a large amount of unrecognised enteric fever amongst children?—Oh, I think there is no doubt about that.

17649. It passes as teething, diarrhœa, and that sort of thing?—Yes. I went into the question of occupation also, which was very suggestive.

17650. (*Sir Michael Foster.*) That would mean class distinction?—Class distinction, yes.

17651. What was the result?—The run of certain occupations was very striking: a betting gentleman, manager of a theatre, publican, commercial traveller, a fishmonger, City man, merchant, caterer, doctor, restaurant keeper, fishmonger, and so on. There was quite a run of occupations of that class; that is to say, the kind of people who were eating oysters.

17652. The result. I see that your 24 per cent. of the cases were determined by the fact of their having eaten oysters within the period of incubation of enteric fever?—Yes.

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17653. Well, we all know the extreme variance in the period of incubation?—Yes.

17654. You must have had some arbitrary working time; what was it?—I did not accept any longer incubation period than 17 days.

17655. 17 days?—Though I should like to add, I have known in other connections an incubation period of 21 days, which I think was distinctly proved.

17656. But it is obviously very desirable that there should be a fixed period taken?—Yes, sir.

17657. In determining, because you may expand or contract the number according to the period?—Yes.

17658. (*Mr. Power.*) In the other direction—17 in one direction—how short a period did you start with?—The point has not arisen in any of the cases which I have investigated of having to include any case in which typhoid fever had begun within two or three days after eating oysters, because in nearly all those cases they were people who had been eating them once a week or once a fortnight or so. But I may mention a point which I have not yet brought out; that is, that quite frequently one had illnesses of this kind; that is, within 24 hours of taking the oysters, violent sickness and diarrhœa occurred, and high temperature with that. A specimen of blood was sent to me for examination for the Widal reaction a negative result obtained; the doctor would call, and say, "I am certain that is typhoid fever." I would take it into the hospital, and a week or ten days later it would give the Widal reaction. Thus there was a double infection, Gaertner poisoning to begin with, and typhoid fever afterwards. That has very frequently happened.

17659. (*Sir Michael Foster.*) Have you had many case of Gaertner poisoning from shell fish?—I can recall about half-a-dozen which I have definitely investigated.

17660. (*Dr. Burn Russell.*) I suppose you have cases in which this preliminary poisoning is not followed by the other specific poisoning?—Yes, I remember one instance where the husband got a violent diarrhœa, and was fairly well after a day or two, and then a fortnight later had typhoid, and the wife got only the diarrhœa, and did not have typhoid afterwards.

17661. I suppose that you admit this, that if you have oysters eaten by a family living in a house such as that first case referred to in your report of 24th March, 1894, the sanitary condition of which is bad, and similar oysters eaten by a family who live under wholesome sanitary conditions, the probability of the specific infection in the former would be much higher than in the latter?—I think the conditions under which they were living would undoubtedly make them more easily victims to the typhoid fever.

17662. It would come as a sort of mordant; it would fix the dye?—Yes, sir.

Dr. E. Klein.

Dr. E. Klein, called; and Examined.

17663. (*Chairman.*) You have sent us a very interesting paper, and I should propose, if you have no objection, that that paper should be entered on our evidence just as it stands?—Yes.

PAPER HANDED IN BY DR. KLEIN.

1. The normal oyster does not harbour within its shell or within its body, bacillus coli communis or other b. coli closely allied to it; microbes, that is, possessing most of the principal characters of b. coli communis. This conclusion is derived from a considerable number of examinations of oysters, taken either from layings in deep waters or from localities to which no sewage or filth has access.

2. B. coli communis, as also other b. coli closely allied to it, were found in oysters taken from pits and from layings which are within reach of sewage pollution, or which were actually and directly polluted with sewage.

3. Speaking generally, the more obvious the sewage pollution of the pit or laying the greater the number (in a given sample) of oysters containing the b. coli communis, the more numerous, i.e., the more readily discoverable is this microbe in the individual oysters.

4. Since b. coli communis is one of the chief microbes of sewage, and is found in everything polluted with such filth, its presence in considerable numbers of oysters in a series of samples from a particular locality may, in my view, be taken to indicate sewage pollution.

5. Bacillus coli communis, as also other b. coli, has no great power of persistence or of survival in the juices of the living oyster. In a short time—from several days to a few weeks—it disappears from the interior of most oysters—English natives, French native oysters, Dutch natives, American blue points. The Portuguese oyster stands in this respect on a somewhat different footing, since owing to the peculiar shape of its shell, filth which has once got into the interior thereof is liable to remain there for considerable periods, certainly much longer than in oysters of the above descriptions.

6. In the accompanying paper, published in the "British Medical Journal," February 21st, 1902, I have described the method of examination and the characters by which b. coli communis has been identified and by which it differs from other coli-like microbes.

7. In examining a sample of oysters for b. coli communis, the amount of juice and liquor of each oyster subjected to analysis has an important bearing on the result of the examination, as is the case with all materials where the polluting matter is subject to greater or lesser dilution. The amount actually analysed of each single oyster was not measured by "platinum loopfuls," but was on an average at least one-third to one-half C.C., which would equal something like 60 to 80 "loopfuls" The number of individual oysters of a given sample examined was at least eight, sometimes as many as 12, and even 16 or 18 oysters of a sample were tested. Only individuals of a perfectly normal character were examined. It made no difference in the result of the examination for b. coli communis, whether the body of the oyster was mashed up in the juice or whether only the (turbid) juices oozing out of the oyster were subjected to the analysis.

8. In addition to b. coli communis, the spores of b. enteritidis sporogenes were looked for, since these are also present in sewage, and are not naturally present in the oyster. The number of the spores of this microbe in sewage being far inferior to that of b. coli communis, larger amounts of the juices and liquor of the oysters were subject to analysis. Under this condition, it was generally found that in most cases where b. coli communis was detected in the oysters of a given sample, the spores of the above microbe were also found. But in some few instances the spores alone were found, not b. coli communis. This was the case when pollution with sewage from a distant source or of older date could not be excluded or was quite probable. The greater resistance of the spores would explain their occurrence in these oysters.

9. When b. coli communis is found in a number of oysters of the same sample, it is highly probable, as already stated, that this is due to recent pollution. Whether such pollution is to be considered as potentially dangerous would depend on the relative and absolute amount of b. coli found in a given sample, on the local conditions of the oyster bed or pit, on the nearness to a sewer outfall, and on the amount of sewage in relation to the volume of water with which it is diluted.

It has to be borne in mind that, in order to condemn oysters as dangerous, it is not necessary to detect in them the bacillus typhosus, nor can they be passed as safe because the b. typhosus is not demonstrated in them.

It is well known that the detection of this microbe in water, oysters, milk, and similar substances, which had been specifically polluted, is subject to very great difficulties.

Further, it is to be remembered that b. typhosus is not the only microbe of a pathogenic nature which may be present in excremental matters. To name an example: In oysters taken from Emsworth I have found pathogenic b. coli, which in all respects corresponds to the bacillus enteritidis of Gärtner; and in certain circumstances I should search in oysters for the cholera vibrio.

10. With few exceptions, all the samples of oysters that I have recently examined were submitted to me by the Fishmongers' Company, and they were collected by the Company's officers and inspectors, noting also the exact locality, time, and state of tide.

(Signed) E. Klein.

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THE BACTERIOSCOPIC DIAGNOSIS OF SEWAGE POLLUTION OF SHELL FISH.

It appears from various published accounts that those who have worked at the bacteriology of shell fish are disinclined to attach any precise significance to the occurrence in them of certain microbes which come under the term of bacillus coli and coli-like bacteria. It is therefore with the object of inviting reconsideration of the subject with a view to obtaining unanimity in the matter of a standard for diagnosis, that I offer here the following remarks. After a considerable experience, I have arrived at the conclusion that, due consideration being given to all the facts as to the conditions of the precise locality whence shell fish have been derived, the presence in greater or less amount in such shell fish of certain bacteria affords a trustworthy indication as to whether or not such shell fish have been recently exposed to undesirable fouling (sewage pollution).

It is an important question — important from the public health point of view—whether, in the event of a small amount only of fouling being demonstrable, such shell fish are to be rejected as unfit for consumption. It will be admitted, I think, that oysters which are laid down in a locality to which sewage discharged at a distant point into the tideway has access in very small amounts only occasionally stand in a different position—*qua* possible disease production—from oysters which are practically continuously exposed to, at times are actually flooded by, crude sewage discharged in their immediate neighbourhood; and, further, it is obvious that there is an important distinction to be made between the latter and other oysters which are miles removed from a sewer outfall, but which, owing to being laid down in a shallow part of a bay, may still be, and at intervals only are, brought into contact with matters that have long before, perhaps many days previously, been discharged from sewage outfalls. This last category of oysters could only in a very remote degree be considered as potential disease producers.

Oysters, moreover, stand in a different position from cockles; for, whereas the former when they have imbibed the B. typhosus soon (after 10 to 14 days) discard it again when placed in clean sea water, the latter (cockles) retain this microbe, and, as I have shown (Report of the Local Government Board, 1900-1, p. 570), are capable even of becoming a nidus for its multiplication.

By estimating, having due regard to the above considerations, the relative proportion between the number of shell fish yielding positive as compared with those yielding negative results on bacterioscopic examination, I consider, from a large experience, that it is possible to diagnose approximately the percentage value of probable sewage pollution in a given instance. To this end, and in a positive sense, the presence of B. coli communis, or the typical B. coli, together with the spores of B. (enteritidis) sporogenes is all-important. Latterly, in addition, the presence of streptococci (Houston) which stain by the Gram method have been found to afford valuable confirmatory evidence.

THE B. COLI GROUP

B. coli communis, or the typical B. coli, as is well known, belongs to a tribe of bacteria comprising many and different species and their varieties; indeed, with increase in the number of workers and with multiplication of methods, the members of the great tribe of coli bacilli become more numerously recognised and identified. All coli bacilli and coli-like bacilli have certain characters in common. But there are other characters by which they differ from one another in a more or less definite manner.

All coli bacilli and coli-like bacilli, including the typhoid bacilli, have the following characters in common:[1] (a) They grow well on gelatine at ordinary temperature, although they grow, of course, better at 37° C.; (b) they cause, when growing in broth culture at 37° C., in 24 hours uniform turbidity, due to their rapid multiplication; (c) they are capable of growing in broth, gelatine, or agar to which 0·05 per cent. phenol had been added; (d) they are capable of growing in the depth of the culture media (are in effect facultative anaërobes), although their growth on the surface—that is, exposed to oxygen of the air—is quicker and more copious; (e) they do not at any time liquefy gelatine—namely, do not peptonise gelatine. [This latter character—namely, not liquefying the gelatine—is of importance, since there have become known certain microbes which in morphological and some cultural characters resemble the coli bacilli in a marked degree, but which on continued observation, owing to their more or less slow liquefaction of the gelatine, can with certainty be distinguished from them][2]; (f) growing on the surface of gelatine their young colonies are flat, dry-looking, more or less translucent expansions which can be best compared with a vine leaf, that is, a prominent excentric or sometimes central thickened part and a filmy crenate irregular peripheral portion; (g) in streak culture on gelatine they form a rapidly expanding, flat, dry, more or less translucent band with irregular crenate margin; (h) under the microscope they are cylindrical rods, showing more or less pronounced motility; they do not stain by the Gram method.

In some species the motility is great, and is observed on most individuals in the hanging drop preparation, in other species only few individuals show this motility; but in all cases the motility is observed only in the microbes of recent or fairly recent cultures in broth, on gelatine or agar; when stained by suitable methods it can be shown that they possess flagella—instruments of their motility—and in this respect there exist very great differences amongst the different groups and even amongst the different species. Thus while some have few flagella attached to their ends, others have numerous flagella distributed over the whole surface of the bacilli; and while in some species the flagella are, comparatively speaking, thick, coarse, and slightly wavy, in others they are thin, long, and spiral.

These are the characteristics which may be said to belong to all the known species of coli bacilli and coli-like bacilli, including the typhoid bacilli, and it must be obvious that if the examination of a particular microbe under investigation does not extend beyond ascertaining the above characters in part or as a whole, the identification of the species or variety to which the microbe in question belongs cannot safely be made. This is a point which too often is lost sight of, and accordingly some serious mistakes are liable to be committed.

I shall show presently, as regards coli-like bacilli, that a good many more characters have to be ascertained before any definite opinion as to exact species can be offered, but I will here anticipate by stating that so far as our present knowledge goes—and it unfortunately does not go very far as yet—we can do no more than assert that there exist certain groups which are fairly well separated from one another, and similarly we are constrained to admit that between some of the well-defined species within the groups there are others which, whether they be called varieties or species, must be considered intermediary or transitional. In illustration I would note that most bacteriologists who have devoted particular attention to this subject are agreed that three[3] groups of these bacilli stand out fairly well, having fairly well defined boundaries, although each group may, and does, contain several species or varieties. The three groups in question are (1) the group of B. coli communis, (2) the group of B. (enteritidis) Gaertner, and (3) the group of B. typhosus.

I.—*Bacillus Coli Communis.*

Bacillus coli communis, or the typical B. coli,[4] belongs to a group which possesses, besides the above general features, the following additional characters:

(a) It ferments—that is, forms rapidly acid and gas glucose, as well as lactose. A very useful mode of glucose culture is the one first introduced by Dr. MacConkey—namely, litmus, glucose, taurocholate of soda, peptone, and water. Inside the fluid is a fermen-

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[1] It will be understood that the account here given is a summary of the results of investigations by many observers.

[2] In the oyster this kind of liquefying "coli-like" microbe is occasionally met with.

[3] I do not mean that these three groups exhaust the whole tribe, but only that we have better knowledge of them than of others, as for example, of the group of B. lactis aërogenes, of B. dysenteriae of the group that cause hæmorrhagic septicaemia, etc.

[4] In my papers in the Report of the Medical Officer of the Local Government Board, 1892-3, and also in that on Oyster Culture and Disease, 1894-5, pp. 110 and 111, I have carefully noted the characters of this microbe, as also of the B. typhosus.

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tation tube—that is, an inverted small test tube—so as to indicate the presence of gas, if any, during incubation. But while this MacConkey medium is very useful, it is not a short cut to success any more than any other more or less reputed material or method. If B. coli communis be introduced into a MacConkey tube, and this be incubated at 37° C. for 24 hours, it will be found strongly acid, that is red, and showing copious gas, while the inner small inverted tube will be lifted out a long way above the level of the fluid owing to the presence of copious gas. But this condition, although suggestive, is no proof (does not suffice to indicate) that the change is necessarily due to B. coli communis or to excremental pollution, because bacteria may produce the same change—that is, acid and gas—bacteria, for instance, not necessarily connected with sewage. Another culture tube containing litmus, lactose, peptone water, with a small inverted tube inside the fluid, may afford important corroborative testimony. If both the MacConkey tube and this other litmus lactose peptone tube show after 24 hours' incubation at 37° C. strong acid production and copious gas, it may be taken almost for certain that there is present B. coli communis, or some coli bacillus very nearly allied. I said advisedly "almost," because in some few instances the microbe which produced the above change was upon further test found after all not to be *the* typical B. coli. In the majority of instances, however, the preliminary diagnosis will on further test cultures be found correct. As stated just now, if a positive result in the MacConkey tube as well as in the lactose peptone tube is evident already in 24 hours at 37° C. incubation, there is afforded presumptive evidence of the presence of gas-forming coli-like bacteria, although not necessarily B. coli communis, and for this reason subcultures are essential.

(b) The B. coli communis usually curdles milk at 37° C. in 24 to 48 hours.

(c) It forms indol in broth culture incubated at 37° C. for three to four days.

(d) It bubbles, that is, forms numerous gas bubbles in shake culture in beef broth peptone gelatine with or without special addition of glucose.

(e) It gives positive result when cultivated in broth to which neutral red has been added, namely, causing in 24 to 48 hours' incubation at 37° C. distinct change of the original red into fluorescent green.

(f) It possesses a limited number of flagella, two, three, or more often attached endwise, the flagella being relatively coarse and a little wavy.

(g) On steamed potato B. coli communis forms a moist, more or less brownish growth.

While these are special characters of the B. coli communis group, there are differences between different varieties of this group, for instance, as regards some of those varieties the colonies are less translucent than others; in some the bacilli are more cylindrical than in others, of course cultivated under precisely the same conditions; and in some the bacilli are distinctly more motile in the hanging drop than in others, and the flagella in one variety more numerous than in another; further, one variety forms indol more distinctly and more quickly than in another.

A considerable experience enables me to state that if the following tests are positive: Glucose as well as lactose (red and full of gas in 24 hours); shake gelatine (ordinary beef broth gelatine full of gas bubbles in 24 hours); litmus milk (red and curdled in 24 to 48 hours); neutral red positive; indol formed in broth culture, there is every probability that the observer is dealing with the true B. coli communis.

II.—*The Bacillus (Enteritidis) Gaertner.*

This group comprises coli-like bacilli with the following special characters which separate it from the group of B. coli communis; (a) It ferments glucose, but does not ferment lactose; (b) after a short acid stage it forms alkali distinctly in litmus milk, the medium turns slate colour after several days' incubation at 37° C., while the milk remains fluid; (c) it does not form indol in broth; (d) it forms a translucent colourless growth on steamed potato; (e) it is more motile than B. coli communis in the hanging drop and possesses numerous thin spiral flagella distributed over the whole surface of the bacilli, like those of the typhoid bacilli (see below). It, like B. coli communis, bubbles gelatine in shake culture and gives positive neutral red test.

III.—*The Bacillus Typhosus.*

This is the microbe of typhoid fever and the best known representative of this group. It possesses the following characters: (a) It is very motile, and in recent cultures (gelatine) very cylindrical, many forms thread-like; it grows slower than the two former on gelatine, and forms thereon a more translucent growth; (b) it form a colourless translucent film on potato; (c) it forms acid slowly; (d) it does not curdle milk and does not produce indol; (e) it does not ferment glucose or lactose; (f) it does not bubble either ordinary gelatine or glucose gelatine; (g) it does not give the neutral red test; (h) it possesses numerous flagella, thin, long, and spiral, distributed over its surface; (i) the bacilli of an emulsion are distinctly agglutinated (clumped) by the blood of a typhoid-immunised animal in higher dilutions than any members of the other two groups.

There are several additional means by which the three groups can be distinguished, but these means are less reliable and are not essential—for example, growth in Proskauer and Capaldi's medium, growth in litmus glucose agar plates (Horrocks), in litmus lactose phenol agar plates (Chantemesse), in Elsner's potato gelatine, in Weil's medium, in Drigalski and Conradi medium, and others.

As with the first group, namely, that of B. coli communis, so with the Gaertner and the typhoid group varieties or strains are comprised within them which differ from one another slightly, both in morphological respects (some are more cylindrical than others, some have more flagella than others), and in action on rodents when inoculated into them, some being more virulent than others.

Other Bacilli of the B. Coli Group.

These three groups, as already mentioned, do not by any means exhaust the list of observed coli bacilli. Some aberrant forms approach more to one of these groups than to another; in fact, everyone who has experience in the matter knows that in the various animal tissues and the most various other materials which are assumed to be directly or indirectly polluted, or at any rate are open to be polluted, with filth of all kinds, microbes are met with which must needs be referred to the tribe of B. coli. But it is extremely difficult to judge, and is only possible to do so after prolonged examination, whether they belong to the group of B. coli communis or to that of B. Gaertner or to some other group, some partaking of certain, but not all, the characters distinctive of B. coli communis, others again partaking of some, but not all, the distinctive characters of B. Gaertner, or again of B. typhosus. Some are poisonous and virulent when introduced into rodents, while others are not.

This seems to explain why it would be unjustifiable to draw any conclusion as to the exact derivation of any material from the presence in it of such insufficiently defined coli-like microbes. These being present in many substances in Nature, their exact habitat not being sufficiently known whether, and to what extent, they bear relation to filth, cannot at present be used for diagnostic purposes in the same sense as B. coli communis.

Conclusions.

The detection, therefore, of the presence of coli-like bacilli bearing no near resemblance to B. coli communis does not permit any definite expression of opinion as to the probable or even possible derivation from sewage, or as to probable pollution with filth, of the material from whichr such microbe has been isolated. It is different, however, with the microbe above referred to in detail as B. coli communis—that is, the typical B. coli. As to this micro-organism, it is known for certan that its common habitat is the bowels of man and of the higher animals, and that domestic sewage and excremental matter and everything directly or indirectly polluted with these matters contains the B coli communis—that is, the typical B. coli. In domestic sewage this microbe is present to the extent of 100,000 to 800,000 per 1 c.cm. of the sewage, and Dr. Houston and myself have shown that sewage added to sterile water in such small quantities as to defy chemical analysis is readily detected by the bacterioscopic test—namely, the detection of B. coli communis.

To summarise, then, the foregoing, the following propositions hold good:

1. The circumstance that a microbe shows the characters common to all groups of the coli tribe does not suffice to identify it for useful purposes. For proof that

It is B. coli communis, or that it belongs to the group of B. Gaertner or B. typhosus group, it has to comply with the several tests agreed by all observers as characteristic of one or other of these groups.

2. The fact that a microbe owing to insufficient response to certain presented tests can only be described as a coli-like microbe, is at present of indeterminate value in making a definite diagnosis of sewage or other pollution.

3. B. coli communis is a microbe which has its habitat in bowel discharges, that is, excremental matters, and is contained therein in enormous numbers ; its presence, therefore, in any material in appreciable and relatively large amounts is highly suggestive of sewage and excremental pollution.

THE B. COLI GROUP IN RELATION TO SHELL FISH.

Passing now to the examination of shell fish—namely, cockles, mussels, and oysters—the question of the greatest importance to the bacteriologist is, Do these animals contain normally B. coli communis? In my report to the Medical Officer of the Local Government Board, 1894-5, I have shown that many oysters are free from B. coli communis, and that oysters retained in localities polluted with sewage are liable to contain the typical B. coli ; that is, the B. coli communis. Professors Herdman and Boyce[*] have shown by their examinations that except in two out of a large number of shell fish (19 batches of oysters, 18 batches of cockles, and 18 batches of mussels) the B. coli communis was found absent.

Analysing their Tables II., III., and IV. (pp. 48 and 49), which give a summary of the results of the analyses of shell fish by them, it will be seen that with the exception of oyster 32 and oyster 36 (Table II., p. 48) which might have contained the B. coli communis—the tests employed were insufficient to afford a positive diagnosis—none of the oysters (19 batches) showed the B. coli communis ; nor (Table III., p. 49) did any of the 18 batches of mussels ; nor (Table IV.) did any of the 18 batches of cockles contain the B. coli communis, as indeed must be obvious to anyone who knows what the reactions of B. coli communis are. Professor Boyce, in subsequent reports on the analysis of shell fish for the Corporation of Liverpool, mentions in a general way the frequent presence in the shell fish bought in Liverpool shops of B. coli, but not giving the details of the examination, it is not possible to draw any conclusion as to the kind of B. coli.

Recently I have again had further opportunity of analysing a considerable number of various kinds of oysters, and as a result I am in a position to affirm :

1. That the B. coli communis, or the typical B. coli, is not a natural inhabitant of these shell fish. Fifty-six oysters examined in one week, 24 in another, 20 in a third, 22 in a fourth week, and five batches of 10 oysters each in a fifth week—some derived from deep-sea layings, others from layings to which practically no sewage has access—failed to show the presence of B. coli communis, although so much as $\frac{1}{2}$ c.cm. of the juice and liquor of the interior of each oyster was subjected to the special analysis.

2. The nearer to sewage outfalls, that is, the more exposed oysters and cockles are to sewage pollution, the greater the percentage of these shell fish polluted with B. coli communis.

3. The further away from sewage outfalls, or the smaller the amount of sewage accessible to the oysters or cockles, the smaller the number of these shell fish that are found to contain in the interior of their shells the B. coli communis.

Method of Examination.

The analysis of cockles and oysters for the purpose of detecting the presence of B. coli communis was carried out by me in the following manner : Of each batch of cockles, 12 to 24 individuals were examined, and of each batch or sample of oysters, 10, 12, and sometimes 16 or 18 individuals. In all cases the shell of the fresh and living mollusc was thoroughly brushed with a clean brush under the running tap ; then it was dried with clean cloth, opened with sterile instrument, and with the juice and liquor within the shell, cultures were established. Of each of six or eight oysters, about $\frac{1}{5}$–$\frac{1}{3}$ c.cm.[*] of this liquor was added to one MacConkey tube, and the same amount to one lactose tube ; of further two, sometimes four, oysters, $\frac{1}{5}$–$\frac{1}{3}$ c.cm. of this liquor was added to each of two, or in some cases four, phenol broth tubes, or in lieu (in the earlier analyses) about three big drops of the juice of each of two animals to establish two litmus glucose agar surface plates. Next day, that is, after twenty-four hours' incubation at 37° C., the necessary subcultures were made from the original tubes and plates in order to demonstrate the presence of B. coli communis ; streak and shake gelatine cultures, MacConkey and lactose peptone tubes, litmus milk, ordinary broth (with and without neutral red), litmus, lactose phenol agar plates, etc. From the turbid phenol broth also microscopic specimens stained by Gram method were made in order to detect the streptococci. Cultures on solid media may also be employed for their detection.

BACILLUS ENTERITIDIS SPOROGENES.

Investigation of shell fish in the above sense has not been limited to the demonstration of B. coli communis. Examination has sought also the demonstration of the spores of B. enteritidis sporogenes. Spores of this bacillus are constantly present in domestic sewage to the number (as shown by Dr. Houston and myself) of from between 100 to 2,000 per 1 c.cm. These spores, as I have repeatedly shown, are present also in manure (consequently in street dust), and in all substances exposed to pollution with filth, manure, sewage, etc.

The presence, therefore, in shell fish of the spores of B. enteritidis sporogenes as well as B. coli communis may serve as an additional indication of possibly recent sewage pollution ; at least, it is tolerably certain that oysters and cockles not laid down in sewage-polluted waters are free from the spores of this anaërobe, and also that the further away from definite sewage pollution the smaller the number of these shell fish which contain these spores.

Since the spores of B. (enteritidis) sporogenes are in sewage greatly inferior in numbers to the B. coli communis, it is necessary to use a larger quantity (0·5 c.cm.) of the shell fish material (juice and liquor) for each anaërobic milk-culture tube if that anaërobe (B. enteritidis sporogenes) is to be demonstrated. Although, as I have repeatedly described, the milk culture may be typically changed by the twenty-four to thirty-six hours' growth of the above anaërobe, it does not follow that the so changed milk culture must be that of the B. (enteritidis) sporogenes ; and in this connection I cannot do better than illustrate by a reference to the already quoted papers by Professors Herdman and Boyce, that even experienced observers are liable to mistake some other anaërobe for the B. (enteritidis) sporogenes. On p. 55 (loc. cit.) these observers state among their conclusions :

> "17. We have shown the frequent presence in various shell fish of anaërobic spore-bearing bacilli, showing the characteristics of the B. enteritidis sporogenes recently described by Klein."

Now, examining the evidence on which this conclusion is based (see the table on p. 51), it is found that the authors have had before them the real virulent B. enteritidis sporogenes in cockle 1, and possibly also in oyster 4. But that in all other shell fish examined by them (10 oysters, 6 mussels, 3 cockles, 1 periwinkle) the resulting growth was decidedly not that of B. enteritidis sporogenes (Klein), and for the sufficient reason that this latter microbe does not at any time form spores in milk culture. The authors referred to, be it noted, describe the microbes cultivated by them in the milk cultures as either short or large spore-bearing bacilli.

It is quite clear, therefore, from Professors Herdman and Boyce's table that, with the exception of 1, or at most 2, shell fish out of the 22 bought by them indiscriminately in town shops, the shell fish examined by them did not contain the B. (enteritidis) sporogenes. This is quite in agreement with what I find from my own recent investigations ; out of 56 oysters analysed within a week, 1 only contained the spores of this anaërobe. But out of other 8 oysters coming from a distinctly sewage-polluted laying, 4 contained these spores. Again, in a batch of 12 oysters coming from a laying in deep water far out from the shore not a single one contained the microbe, whereas 4 out of 10

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[*] Thompson-Yates's Laboratory Report, vol. ii.

[†] In the case of cockles a lesser quantity is used, because there is not sufficient in many of them to supply the required number of tubes.

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in one batch, 5 out of 20 in another batch of oysters of the same locality, but laid comparatively near the sewer outfalls, contained the spores of B. (enteritidis) sporogenes, using always of each oyster 0·5 c.cm. for a culture tube.

It must, however, be obvious that the presence of the spores of B. (enteritidis) sporogenes alone—that is, without the simultaneous presence of B. coli communis—cannot be held sufficient proof that the oysters or cockles have been subjected to recent sewage pollution. For the spores of B. (enteritidis) sporogenes being, like other spores, highly resistant, may have found their way to the locality in which the shell fish had been kept any time (long or short) previous. But found together with B. coli communis (and with streptococci) in oysters, the spores very probably had arrived in the locality recently, and in direct association with sewage and excremental matters.

17664. (*Sir Michael Foster.*) Would you kindly tell the Commission, Dr. Klein, what instructions you give with regard to the collection of your oysters. Are they always gathered at the same time of tide, or do you sometimes have them at the ebb and sometimes at the flood?—I did not give any instructions myself, but it is understood that the inspector who is going to collect them comes to me first, and we agree about the locality, and he generally collects them at ebb tide, and it is generally so stated in most of these samples that I have examined—it is not stated in all, but in most of them the time is stated when they were collected—half ebb, or so much after the ebb has begun.

17665. But your general instructions are to gather at ebb tide?—I think that is the instruction that the inspector generally has; yes.

17666. I suppose the bacilli that are present in the oyster are mainly in the pallial chamber, as it is called, and in the branchial chamber?—That is so.

17667. I suppose very few enter the tissues?—Very few indeed, and those that are in the tissue are generally organisms that do not grow at blood heat; they generally grow only at low temperatures.

17668. For instance, the bacillus coli I suppose grows in the pallial chamber and in the branchial chamber also to a certain extent, and can get into the intestines?—Yes. And can get into the intestines.

17669. Have you examined the intestines?—I have made comparative examination. It makes no difference whatever whether you cut up the whole body of the oyster or whether you take only the fluid which oozes out into the pallial or the branchial chambers.

17670. As a matter of simplicity of operation it is best to content yourself with the fluid in the pallial chamber?—It is generally a more or less turbid fluid containing a large number of leucocytes and ciliated corpuscles; if there is anything foreign present it will be found there.

17671. Have we any data how often the water in the pallial chamber is renewed under varying circumstances?—Not at all; I understand it is a popular belief amongst the people that with the incoming tide the oyster opens, and as soon as ebb sets in the oyster closes. I do not know whether that is really an observed fact.

17672. Then when its shell is closed there is a certain current goes through, is there not?—I would not like to say; I do not know it myself.

17673. I observe you take a percentage of oysters which are contaminated; say, you examine a dozen, and you find a certain number of them contaminated?—Yes.

17674. You do not say anything as to the number of bacilli which you regard as evidence of contamination. Is one bacillus in your view contamination?—Well, the experiment is made with no regard to the actual number of the bacilli; we do not generally make plates; we place the material into a fluid, and the fluid develops the organisms, therefore I could not say that what has developed has developed out of one bacillus or out of several.

17675. You have made no observation by plate cultures to see?—Except in special cases, generally not; mainly by fluid cultivations.

17676. (*Mr. Power.*) Do you inoculate more than one tube?—Yes, 14 to 16 tubes.

17677. (*Sir Michael Foster.*) At all events there is a sufficient quantity of bacillus to give you your growth in the tubes?—Yes.

17678. And that is your evidence of contamination?—Yes.

17679. Then you distinguish the true bacillus coli from the other bacillus coli?—Yes.

17680. And call the latter paracoli?—No, I do not call them both coli communis, because I do not know whether and what relationship exists between them.

17681. The differentiations are partly morphological, partly physiological, or biological?—Yes, that is so.

17682. Now what evidence is there that a bacillus under change of environment may change its characters?—Very little evidence as regards bacillus coli. There is some evidence, but you are speaking of coli particularly.

17683. I am speaking of coli particularly. Is there not evidence, for instance, that the indol reaction may be taken away, or may be given to coli?—Certainly, may be taken away; but we do not know the conditions under which those changes do take place. We know that in the laboratory such is the case with bacillus coli communis, thus, for instance, our old laboratory bacillus coli communis fails to give one of the tests. Perhaps later by cultivating in a new medium, or some other new conditions, it might assume its old characters again, but under what conditions that takes place in nature we do not know. It is quite possible that several of the coli-like organisms in sewage, may have some definite relation to bacillus coli communis, but that, of course, is only a supposition.

17684. (*Mr. Power.*) You see no modification of coli parallel with the modification of cholera vibrio under your own examination?—No. As I said before, under continued cultivation such a thing did occur with a bacillus coli which has given last year very good indol. This year it fails to respond to this test, for this reason, we had recently to renew our stock of bacillus coli communis because our old bacillus coli communis fails to give the indol reaction. We obtained this new one from sewage.

17685. (*Sir Michael Foster.*) In the course of cultivation it had lost the power of indol reaction?—It had lost the power.

17686. I gather that your diagnosis of the bacillus coli is, so to speak, one resulting from an accumulation of characters, and the more characters you have the more confident you feel that it is the true bacillus coli?—Yes, that is so.

17687. The true bacillus coli, do I gather, in your opinion, comes from the intestine alone?—As far as we know at present it is always present in the intestinal contents.

17688. And when you find it elsewhere you have reason to think that it came from the intestine originally?—Yes, that is generally the case, that is to say that wherever you find it there is always a very strong suspicion that it is derived from the intestine.

17689. (*Mr. Power.*) You do not mean the human intestine necessarily?—From the human or animal intestine.

17690. (*Sir Michael Foster.*) From any animal intestine?—As far as I have examined, from domestic animals.

17691. Does it come from domestic cattle?—Yes.

17692. Does it come from horses?—Yes, certainly. I have limited my observations to domestic animals. I am told also that in fowls there is the bacillus coli communis of the ordinary type.

17693. What you would call true bacillus coli communis?—Yes, the typical.

17694. And fish?—I do not know about fish.

17695. You have studied a bacillus coli from cattle?—Yes.

17696. Is that absolutely identical with your bacillus coli from man?—I have recently had two samples of intestine of cattle subjected to that particular examination, and the bacillus coli that was obtained certainly had all those chief characteristics that I mentioned. Morphologically there was a slight difference; it was much more cylindrical than the bacillus coli from the human intestine, but the principal characters enumerated as regards its power of fermentation of lactose and glucose, as regards its giving indol, its capability of bubbling ordinary gelatine; in streak culture, in the ordinary shake culture, and in the ordinary plate culture its characters are those of the bacillus coli communis of man.

17697. Then supposing that you find, I mean an appreciable quantity of true bacillus coli, you are sure that that comes from the intestines as far as you know?—As far as I know, yes.

17698. Well, you have very strong evidence indeed, you may be almost sure that that comes from the intestine?—Well, I should say that; yes. I should say that if I find bacillus coli with the characters of the typical bacillus coli, I should say that it is highly probable it is derived from the intestine.

17699. But it might come from the intestine of cattle?—Certainly.

17700. And not necessarily from man—from the intestine of man?—No.

17701. Then the bacillus enteritidis sporogenes that has allies, I take it just like the bacillus coli?—I do not know that.

17702. I thought Professor Boyce described some forms?—That was not the bacillus enteritidis sporogenes.

17703. That has nothing to do with it?—No.

17704. I rather gathered that you recognised a certain resemblance, but it was not the true one?—Well, true or not true, it was not it. I do not call it the true one.

17705. You yourself did not recognise it?—I am quite sure it is not the true one.

17706. You have a difficulty in distinguishing the true bacillus coli from other bacillus coli, but you have no difficulty in distinguishing the enteritidis sporogenes?—You see the difficulties are these: the bacillus coli communis has been worked for so many years by so many observers; the bacillus enteritidis sporogenes has not; therefore we know a great deal more about the bacillus coli communis and similar organisms than we know about the bacillus enteritidis sporogenes.

17707. But there is a behaviour in milk that might lead a person to suspect enteritidis sporogenes when you had not got it?—That is so. In the experiments of Professor Boyce and Professor Herdman the same change in the milk was produced as that by the enteritidis sporogenes; but they found that it formed spores in the milk, whereas the bacillus enteritidis sporogenes never forms spores in milk. They found in some of their injections into the guinea-pig the result was either nil or very slight. Well, if it is nil it cannot be enteritidis sporogenes, and so I gather from the table which they published that perhaps in one or two cases they had the true enteritidis sporogenes, but in most cases where they have made microscopic examination and found spore-bearing bacilli in the milk, I should say that they had not the enteritidis sporogenes.

17708. (*Mr. Power.*) You have never found B. enteritidis sporogenes form spores in culture in the laboratory?—Not in milk culture.

17709. (*Sir Michael Foster.*) That also comes from the intestines?—Yes; I think it does.

17710. Can you say of that as you can say of the bacillus coli, that where it occurs it is, at all events, extremely probable, if not certain, that it has come from the intestine?—Do you mean the bacillus coli and the bacillus enteritidis sporogenes?

17711. Can you make the same assertion of the bacillus enteritidis sporogenes as of the bacillus coli?—I should certainly say that wherever the bacillus enteritidis sporogenes has occurred it is derived from animal intestine or human intestine directly or indirectly.

17712. It occurs in the intestine of animals as in man?—Oh, yes, in horses in abundance, and that is why the street dust contains plenty of the spores.

17713. (*Mr. Power.*) Cattle, too?—I have not found it in cattle in appreciable number.

17714. (*Sir Michael Foster.*) Birds?—I have not examined them in this direction.

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17715. Do you know if others have—from the literature of the subject?—There is very little literature of the subject; it is too recent.

17716. The bacillus enteritidis sporogenes occurs generally in the intestine, at all events, of man, and in certain relations to the bacillus coli, does it not?—Numerically.

17717. Numerically?—Yes, roughly speaking, it does.

17718. But the distribution outside man seems to be very variable—the relative distribution of the two?—Yes.

17719. And sometimes you get bacillus coli alone, and sometimes you get bacillus enteritidis sporogenes alone?—Yes, that is so.

17720. In the intestine you get them generally together and roughly in a certain proportion?—Yes, the explanation is this, that in the one case where there are only bacillus enteritidis sporogenes found the bacillus coli has vanished—has gone. The sporogenes having spores is, of course, more permanent.

17721-2. But where you get the bacillus coli without the sporogenes?—This is very likely due to the fact that the bacillus coli is very much more abundant than the bacillus sporogenes.

17723. There have been cases, I think—I speak now from memory—where I have seen coli abundant, and yet not any enteritidis.

17724. (*Dr. Houston.*) Do you mean sewage?

(*Sir Michael Foster.*) Yes.

(*Dr. Houston.*) It is a rather difficult thing to get, because the difference between the numbers is so great.

17725. (*Sir Michael Foster.*) I thought in reading that once or twice I had been struck with the fact that there was, I forget how much there was, bacillus coli, but bacillus coli?—Some samples of sewage may contain 1,000,000—2,000,000 bacillus coli communis, and perhaps only between 100 and 2,000 spores of enteritidis sporogenes.

17726. You are inclined to think that bacillus coli is found alone. The enteritidis is missing simply because it is less abundant?—Yes, I think that is a very fair explanation.

17727. And where the sporogenes occur alone is because it is more persistent?—It is more persistent, and the pollution is not so recent; the addition of sewage has not been so recent.

17728. That being the case, then, if you distinguish the true bacillus coli, and you have evidence of the enteritidis, I suppose you can infer that they arose from some intestine?—Yes, I think so.

17729. And if you found the two, it rather strengthens the argument, does it not?—It rather strengthens the argument. I should add also that if you find streptococcus or Gaertner bacillus, the argument is still stronger.

17730. (*Mr. Power.*) Are you not assuming that it does not multiply outside the animal body?—That depends on the conditions under which it is placed. If it is kept in sewage, it would multiply.

17731. (*Sir Michael Foster.*) If it had multiplied, it would have had its origin originally in some intestine?—I think so.

17732. It might be the intestine of cattle, not of man?—It might be cattle—pigs, horses, or sheep—they all contain bacillus coli communis.

17733. Therefore the presence of either of them, or both of them alone, is by itself evidence of sewage contamination?—Of human? It need not be human sewage.

17734. Because in the majority of human sewage—I mean the amount of animal excreta, is exceedingly small, almost negligible, is it not?—Well, I would not like to exclude animals.

17735. Anyhow, you might have, for instance, in a meadow, with a large number of cattle—the water there might be carrying down a considerable quantity?—I may say I have examined waters coming from localities where there is no house near, only a farm, and where the water did contain both coli communis and spores of sporogenes. Yes, that is so.

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17736. Quite so; so that the presence of either or both of them, *per se*, is not an indication of artificial sewage contamination?—No, not necessarily human sewage.

17737. What you need in addition is some topographical evidence?—Certainly. We could not do without this or the bacterioscopic analysis. I have mentioned in my evidence that both are required.

17738. Quite so; I only want it brought out very strongly, because one has seen an assertion here or there that the oysters were contaminated, because you had found only bacillus coli or the enteritidis, or both. Now you would not take that position; you would not say that the oysters were contaminated simply because you had found the bacillus coli?—It depends where they come from, and it depends upon the number—the amount—the number of oysters that were found contaminated.

17739. That would require, as you said just now, some very topographical evidence that the bacillus coli has come from the sewage?—Certainly, from human sewage.

17740. So that you would repudiate the inference that because the bacillus coli—because you have said the bacillus coli was there, therefore that oyster must have been contaminated by sewage?—But has ever anybody said that it was contaminated by human sewage, without reference to the locality?

17741. I think I have seen that stated here or there?—Without reference to locality?

17742. Yes; I mean just simply the broad assertion. I only want your own view. With regard to your own view, you would not assert that the oyster had been contaminated unless you had in addition to the presence of bacillus coli the topographical or other evidence that the coli had been carried from the sewer?—That is so, and I myself would not countenance this without the knowledge of the topographical conditions. I doubt whether any person has said so without such reference.

17743. If one were able to detect the bacillus typhosus with the same ease that one can the bacillus coli. It is much more difficult, is it not, much more difficult?—Not to be compared. I may say that the Emsworth oysters yielded an abundant crop of coli-like bacilli. We searched particularly for bacillus typhosus, and, although we examined eighteen oysters in this particular direction, we could not find the bacillus typhosus in the very great number of cultivations that we made.

17744. We may say, may we not, that the bacillus typhosus has its source solely in the excreta of human typhoid subjects; you may not say that?—No, no; I would not say that.

17745. So that really that would be no greater test of sewage contamination than bacillus coli?—Well, it would in a certain sense be a test, because it is very probable that it is coming from a typhoid case—from a case affected with typhoid fever; but it would be no absolute proof.

17746. What are the sources of bacillus typhosus which have been observed?—They have been observed by Koch and others in human beings that were not affected with typhoid fever.

17747. Have they been observed in any animals?—I do not think they have; no.

17748. That is pre-eminently and distinctly a human microbe?—That may be due to our faulty knowledge of the distribution of this microbe. We have not yet the methods to get at the bacillus typhosus with ease and certainty.

17749. You think it is quite possible that it might be found to be as widespread as the bacillus coli?—No, I would not say that, fortunately; but it is certainly possible several pathogenic forms—varieties of bacillus coli—are much more widely distributed than we know at present. Besides, there is a strong opinion held by some observers that the boundary between certain pathogenic coli and bacillus typhosus is not so very sharp.

17750. Then I may take it that I am expressing your opinion when I say that valuable, of course, as is the discovery of bacillus coli and the enteritidis in the oyster, the real proof of contamination is when you can associate that with topographical evidence of the sewage having been brought to the oyster. That is what you said, I think, just now?—Yes, I would put it so in a general way; but I would not like to be tied down too strictly to this, because you may be a mile from the sewage outfall—and at one time you may find the bacillus coli communis in the oyster, and at another time you miss it, perhaps owing to the large amount of dilution by tidal water.

17751. Those are all details of the topographical evidence which have to be taken into consideration; but my point is simply this: that the topographical evidence is, after all, the strong evidence of contamination?—Strong evidence?

17752. Well, conclusive evidence?—Well, it may be taken as part of the evidence.

17753. The bacillus coli itself, I mean, is not usually pathogenic when swallowed by man?—We do not know sufficient about it; we do not know under what conditions it becomes pathogenic.

17754. Have you any evidence of its being pathogenic?—Yes, but I do not know under what conditions it becomes pathogenic.

17755. It may be under certain conditions even the true bacillus coli; is that your opinion?—My opinion is that there are certain bacilli which belong to the group of bacillus coli communis, because they give all the tests of bacilli coli communis, and yet are pathogenic. I have got two such strains in my laboratory at present.

17756. I am speaking of pathogenic to man?—To man, yes.

17757. Not simple, to a rodent when injected subcutaneously, but when swallowed by man?—Well, I have not made the experiment. We may infer that it is so, but they are highly pathogenic to animals when administered with their food, and differ in this respect from other typical bacillus coli communis, but they are coli communis nevertheless, because they answer to all the tests.

17758. And there has been evidence that they have caused disease in man?—Yes.

17759. That is what I mean?—That is so.

17760. And, of course, must have been introduced, I suppose, through the alimentary canal?—Yes; for instance, by ice creams. I have got at present two strains in my laboratory which are extremely pathogenic to rodents, and which were obtained from ice creams; these had been incriminated on account of having given disease to man.

17761. What kind of disease was that?—Choleraic.

17762. Intestinal disturbances. I should not put it, therefore, in this way, that because the organism is bacillus coli communis and is derived from the intestine, that it may be neglected as not harmful. Under what conditions it becomes harmful we do not know.

17763. We have only evidence of it being harmful under certain conditions. Bacillus coli communis, if it obtains a footing in the small intestne and multiplies very largely there, it is capable of producing a toxin—a very powerful toxin. That toxin can be demonstrated in lesser quantity in the culture tube, too. If certain conditions take place in the human intestine which enable the bacillus coli communis in the small intestine to multiply, it is quite possible that it would generate so much toxin that disease would ensue. The same argument applies to a great many other microbes not solely intestinal.

17764. Then with regard to Gaertner's bacillus; the bacillus enteritidis Gaetner?—Yes.

17765. Is that on the same level as bacillus coli, or is that more distinctly pathogenic, would you say?—Some forms of Gaertner are highly pathogenic, others are not.

17766. There are several cases of disease which may be distinctly, definitely proved?—Yes.

17767. May we go so far as that—definitely proved?—Definitely proved, yes, that bacillus coli, answering to the tests that we accept as those of bacillus Gaertner, have been found connected with food poisoning. There is no doubt, I think, we all accept that. But we have to add this, that there are certain forms that come under the same category morphologically and culturally as the typical bacillus Gaertner, which are not pathogenic.

Whether there is any relation between the known pathogenic and the non-pathogenic varieties is, of course, a matter which is not known.

17768. With regard to the bacillus typhosus, you have there the advantage, have you not, of the test of agglutination ?—Yes, that is an advantage if it is done correctly, but it is not easy to do it correctly.

17769. All tests are that ?—I am speaking particularly of this agglutination test, because it justly occupies a very strong position. The other day Dr. Houston and myself had an organism isolated from some doubtful case of typhoid. This organism answers in most respects to the bacillus typhosus. The case which was suspected to be typhoid turned out afterwards not to be typhoid, and yet this microbe answered to almost all tests, including the agglutination test. I am only mentioning the thing here because we are speaking of the agglutination test. We isolated from the above case an organism which answers in all respects to the bacillus typhosus, and it agglutinates well, yet it has certain characters which at once would take it away from the group of bacillus typhosus. Therefore, although the agglutination is valuable in a certain sense, you must not rely too much on it. If Koch says, "I do not care about other tests, and rely chiefly on agglutination." This is implied by Koch in investigating an outbreak of typhoid fever in Treves. He occupies this unique position. He, in fact, relies chiefly on two things : (1) the organism in litmus Agar plates of Drigalski and Conradi forms bluish colonies, bacillus coli communis forms red colonies ; (2) the organism forming the bluish colonies agglutinates well with typhoid blood ; therefore, he says, the organism must be bacillus typhosus, and where found denotes typhoid fever. This may or may not be right ; as a matter of fact, in a certain percentage of cases the organism behaving in the above manner turns out not to be the bacillus typhosus, since on subcultures it failed to give the tests of this microbe.

17770. There is no such agglutinating test in bacillus coli, is there ?—Well, bacillus coli also ; if you prepare an animal with bacillus coli communis its blood agglutinates the bacillus coli ; if you prepare an animal with bacillus typhosus its blood agglutinates not only bacillus typhosus, but also some coli-like microbes.

17771. Agglutinates bacillus coli ?—Some forms of bacillus coli ; yes.

17772. You can use that agglutination test up to a certain point as a sort of final test?—The way we have proceeded hitherto has been this : after we had the organism subjected to all the tests, and if it answers to these tests, then we subject it finally also to the agglutination test, and we expect it would answer also to that.

17773. (*Mr. Power.*) Can you tell us anything as to the ratio numerically in the typhoid excreta of the bacillus typhosus to the typical bacillus coli ; are there any observations on that?—No.

17774. We know something in sewage of the ratio of bacillus coli to bacillus enteritidis?—Yes.

17775. If you could tell us something of the same nature with regard to the typhoid intestine it would be of advantage ?—I wish we could ; nobody has yet done so.

17776. But the probability is that in the typhoid fever intestine the typhoid bacillus is in very small numbers compared with coli ; would you say that?—Yes, I should say so ; it depends on the stage in the typhoid fever. At the end of the third week, *i.e.*, the sloughing stage, you would find in the stools a great many more bacillus typhosus than in the first or second week, when this microbe is not readily found ; at least some observers have met with great difficulty in finding it.

17777. Generally speaking, do you suspect that in the typhoid fever intestine the ratio of B. coli to B. typhosus might be similar to that between the bacillus coli and the bacillus enteritidis in sewage ?—I should not like to say.

17778. But, at any rate, it is vastly less numerous than bacillus coli, even in the typhoid intestine ?—Oh, yes, very much less.

17779. (*Mr. Stafford.*) Can you differentiate between the human and bovine coli or enteritidis?—No, I do not think so.

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17780. What importance do you ascribe to the coli-like bacillus which you have described ; that No. 2 bacillus coli communis, as also other bacillus coli, are closely allied?—I do not mean by this that they are to be taken as absolutely proved as coming from the same locality as bacillus coli communis. Bacillus coli communis is an inhabitant of the intestine. Whether other bacillus coli, far or near to the bacillus coli communis, is also an inhabitant of the intestines, I am not prepared to say. We know the intestine does contain them, but whether they are not also distributed in other parts we cannot say. We know too little about them.

17781. Have they got any special importance?—Well, they have this importance, that also a great many of these varieties of bacillus coli more or less closely allied to bacillus coli communis occur in sewage. I only wish to be guarded in my statement, and do not wish to include or exclude coli-like microbes. I would rather limit myself as distinct evidence of sewage or excremental matters to bacillus coli communis.

17782. But there is no special significance in the other forms of coli?—I would not say no special significance. Everything, very likely, has got a significance, and the bacillus coli closely allied to bacillus coli communis may have a significance. At present our knowledge does not enable us to say with the same reliance that all coli-like organisms are, or are not, those derived from crude sewage.

17783. What are the methods that you adopt with regard to the finding of the bacillus coli communis and enteritidis?—Do you wish me to give them in detail? I am quite ready to give them, they are as follows : The oysters are brought into the laboratory by the inspector in a bag or basket ; they are properly labelled, and in many cases where there is any doubt they are sealed ; they are taken in hand by my assistant, who thoroughly scrapes the outside, thoroughly scrapes them under running water, and all the mud and dirt is scraped out from the rim all round. When that is done, they are dried with a clean cloth, and with a sterile instrument the shell is opened, and as soon as it is opened I take it in hand. The adductor muscle, of course, has been cut during the process of opening, and then I either make an incision into the body, or, as Sir Michael Foster has already had it, I take the fluid from the pallial or from the branchial chambers. This is a more or less turbid fluid, and is taken up in a freshly-drawn-out glass tube. By constant practice these tubes can be so drawn out as to be of about the same size ; that is to say, I can manage it so that they are one-fifth of a cubic centimetre, or one-sixth, or one-fourth. As soon as the glass tubes are drawn out they are used so as not to introduce any material that does not belong to the oyster. The fluid is taken up and deposited in tubes ; one MacConkey tube, that is to say, a fluid composed of taurocholate of soda, litmus, glucose, peptone, and water. Dr. MacConkey has shown that the addition of taurocholate of soda to a certain degree retards the growth of other organisms, and allows the bacillus coli and similar organisms to multiply. Of course, as I mentioned in the paper above reprinted, this method is very valuable, but it must not be insisted upon as doing everything. It is not a short cut to success any more than any other method. I myself, from considerable experience, have come to the conclusion that for the first 12 to 24 hours this MacConkey tube is very valuable for demonstrating bacillus coli or similar microbes, but afterwards it loses some of its value, because other microbes also growing in the fluid produce changes similar to these that we expect the bacillus coli or similar organisms to produce. The changes are : that owing to its forming acid it turns the litmus red ; bacillus coli communis ferments the glucose in it, and produces gas. A small tube on the inside of the test tube is lifted out by the formation of the gas, so we see at once that the fluid has turned red, and in the tube there is gas. If this be the case we conclude that this is an organism which produces acid, and which ferments glucose. Then we put the same quantity of oyster fluid at the same time that we inoculated the MacConkey tube into a tube containing litmus, lactose, peptone, and water, because the bacillus coli communis ferments also lactose. Bacillus coli communis ferments both glucose and lactose ; bacillus Gaertner, for instance, ferments glucose, but does not ferment lactose, and bacillus typhosus does not ferment either.

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17784. (*Sir Michael Foster.*) Saccharose?—We did not test that; I only use the two sugars—glucose and lactose.

17785. It does ferment, sacchrose, too, does it not?—I suppose so.

17786. Dr. Houston will be able to tell us that?—(*Dr. Houston.*) The B. coli communis of Escherich does not ferment cane-sugar, but very many coli-like-microbes do ferment this sugar?—Then I put a similar quantity into a tube of broth which contains a sufficient amount of phenol—0·05 per cent. of phenol. That is a Parietti tube; the phenol retards the growth of other organisms. It does not retard the growth of coli, or coli like, or typhoid organisms. In some instances we have made also plates for the detection of bacillus coli communis, coli-like microbes, as well as bacillus typhosus. Then we put double the quantity into a milk tube, recently boiled in the milk, so as to detect the spores of bacillus enteritidis sporogenes. Now next day we make a survey of what has happened, and we find, for instance, the MacConkey tube is red and has gas; the lactose tube is not changed. From this we conclude that the first quantity added to the MacConkey tube contained something like bacillus coli; the second quantity did not; the phenol broth is not turbid, therefore there is no bacillus coli, so we say three times one-fifth we have added, and only one of these tubes has something which is bacillus coli. That gives us an indication of the relative amount of bacillus coli in that particular oyster. We find, for instance, in this way that two oysters out of eight or out of 10, as the case may be, have bacillus coli communis. Of course, you must understand all those culture tubes that became changed—that is to say, that show the growth—have to be sub-cultured; they have to be sub-cultured in neutral red broth; they have to be sub-cultured in litmus milk; they have to be sub-cultured in a MacConkey tube, in a lactose tube, in a shake gelatine, and in a streak gelatine, as also in some cases in plates; so that sometimes from one sample of oysters we have to prepare a huge number of cultivations before the diagnosis is made, and when one has to examine, say, 10 samples or 12 samples in a week, that is about all that two or three people can manage. The diagnosis of bacillus coli communis and coli-like organisms rests on a series of cultivations which, I think, can be considered as a fair and reliable number, and we thus get a correct idea whether it is the bacillus coli communis or a coli which has certain characteristics, but which is not bacillus coli communis.

17787. (*Mr. Stafford.*) Is this the method you have always adopted, or recently?—Generally. Sometimes we have to analyse a duplicate sample because the first sample has not, owing to one thing or another, been quite satisfactory. Another lot is taken, and then plates are also made. If a sample is brought from a locality which is obviously grossly polluted—for instance, from some oyster pits which everybody can see are polluted—eight oysters would be perfectly sufficient to form a reliable opinion as to pollution.

17788. Then you take into consideration the place from which you derive your oysters?—Certainly. We always arrange beforehand which place they are to be taken from; if there is any doubt I would not myself make a diagnosis; I would not myself reject oysters as polluted with human sewage on account of the purely bacteriological examination.

17789. Are these the methods usually adopted by others?—I do not know; I could not say what others do.

17790. Well, about the enteritidis sporogenes, how do you examine and determine that?—There we are aided by the milk culture. The inoculated milk on incubation becomes typically changed. This so changed milk is also examined microscopically and tested by experiment.

17791. Is the milk culture quite a satisfactory method?—Yes, that is the simplest method.

17792. Is it reliable?—Perfectly reliable; I think if we have to deal with matters like sewage, or anything contaminated by excremental matter, the demonstration of the bacillus enteriditis sporogenes by the milk culture test is perfectly reliable and satisfactory.

17793. (*Dr. Burn Russell.*) Have you considered at all or made any observations on the risks of contamination of the oysters in the ordinary process of opening?—I do not think there can be any contamination in our process of opening.

17794. You clean the shell carefully?—Oh, yes.

17795. Well, do you know whether this is a market practice of the trade, is there any process of cleansing the outside covering of the oyster before it is put on the market?—I do not think there is. When they are brought from the layings to the laboratory they generally are extremely dirty.

17796. That is an element of some importance. There must be a risk that there is bacterial contamination outside, of its being conveyed in the crude form to the fish in opening?—I should think, yes, there would be.

17797. (*Colonel Harding.*) I suppose you have no sort of doubt that bacillus coli does not exist naturally in the excretion channels of oysters?—No, it does not exist there. Moreover, I think the oyster is capable of eliminating it, comparatively speaking, very rapidly. Bacillus coli cannot exist for any considerable time within the shell of the oyster.

17798. Have you formed an opinion as to what time is necessary to eliminate the bacillus coli?—That depends on the kind of oyster.

17799. And you think that a fortnight in safe waters would be sufficient to eliminate the bacillus coli?—Not for the Portuguese oyster.

17800. Not for the Portuguese oyster?—I except the Portuguese oyster, which is of an entirely different shape. Here is a Portuguese oyster (*showing specimen*). It possesses a socket, so that when dirt gets in this cannot get out but is retained in that socket.

17801. From the flatter form of English natives you would find that a fortnight is sufficient to eliminate bacillus coli?—Oh, I should think less than that.

17802. (*Sir Michael Foster.*) Is it the washing out of the coli; is it not washed out largely?—I think there is more than that.

17803. I do not mean exclusively that, but is it not largely that, that there is a constant current going through the pallial chamber and the branchial chambers?—Certainly, but that is not the only factor. There is something else in the oyster, perhaps the secretion of the oyster, which has an injurious effect on these organisms. For instance, I have had oysters sent from an obviously polluted source, from Flushing, near Falmouth; in that sample nearly every oyster was polluted, containing bacillus coli communis in abundance. From that same source, viz., Flushing, near Falmouth, a second sample was obtained; this was partly laid down in clean sea water in another locality, and partly was brought to my laboratory. These latter were found polluted just like those of the first sample. Some few weeks after the former lot had been relaid in clean sea water they were examined, and only one oyster out of eight was found polluted. Another instance was this: oysters of a certain sample having been found to contain abundantly bacillus coli communis, were found free of this after having been kept in the refrigerator for several days.

17804. The fluid was not changed at all; it remained exactly the same?—Yes, not at all. There they remained for some days—I think it was six days. They were examined again, and I could not find any bacillus coli communis in the same oyster in which I had found them six or seven days before.

17805. But in the cockle, I think you have evidence that there is actual multiplication?—Yes; the cockle is different, and also the mussel is different.

17806. Have you made any observations on the mussel, or only observations on the cockle?—Yes, these observations were all on the cockle.

17807. You have not made any observations on the mussels?—I have examined some samples of mussels. They came all from an obviously polluted locality, and, of course, there was no difficulty in demonstrating in them the bacillus coli communis.

17808. (*Chairman.*) Have you ever examined any American oysters?—Yes, I have.

17809. Coming straight from America?—Not coming straight from America, laid down in English waters. I have examined one sample of Dutch oysters. They came directly from Holland—they had been laid down, however, in deep water, and they were remarkably clean. Then I have examined Portuguese oysters from various parts, outside of England. From Ile de Ré, Arcachon, from Neuil-sur-Mer; the Arcachon Portuguese are very polluted. A great many of these come over to England; they are laid down again in English waters, some in clean waters, others not in clean waters. The Ile de Ré are also oysters which occasionally show contamination. Those that came from Neuil-sur-Mer were remarkably clean. I do not think I have had any American oysters except those which have been laid down in English waters. The American oysters that I have examined were all Bluepoints.

17810. (*Colonel Harding.*) Have you formed any opinion of the extent to which any bacillus coli would be permissible in oysters to pass a standard; would you condemn oysters if there was bacillus coli present at all?—If there is bacillus coli present, say one in eight, and not very abundant in that one, and the locality is such as not to be directly or readily contaminated with sewage, I would pass those oysters; I should not condemn them.

17811. You say not abundant in that one. How many to a c.c.?—That I could not say; but I say, for instance, in the three tubes which I inoculate from one oyster, and perhaps a plate as well, only one tube shows the presence of bacillus coli. That is a very small number. But if, for instance, all the tubes showed indications of bacillus coli communis, I should say there must have been a good many present in that oyster.

17812. Are you able to suggest to the Commission anything in the nature of a standard that might be used for the examination of oysters?—No. If I do not know the locality, I should not give any opinion as regards a case like the one just mentioned, *i.e.*, where only one oyster out of eight or out of ten contains the bacillus coli communis. This I have always stated to those who employed me—for instance, to the Fishmongers' Company. If there is such a small pollution as one in eight or one in ten, you have to take into consideration the locality. On these maps you can see localities like those marked in the river Medway. I have had samples of oysters coming from this part, which might receive sewage from Sheerness or from Queenboro'. If I found one in eight, perhaps, in such a sample contained the bacillus coli communis, I should not pass them; but if I get oysters much further away—several miles further away—and although one in eight oysters contained bacillus coli, I would not be justified in condemning them.

17813. Would you mind explaining why, in the one case, you would consider one in eight would condemn, and in the other case one in eight would not condemn?—Because one is much further away from the locality where the sewage comes from, and, therefore, is potentially less risky than the other.

17814. But if you are to take the presence of bacillus coli in the same proportion in both cases as evidence of sewage contamination, is it not as bad a sign in the one case as in the other?—Well, it is a sign, no doubt, but in the one case where these oysters are laid down nearer to the sewage outfall, the risk is much greater.

17815. Do you not measure the risk in the proportion of one in eight?—You could not do that; you would in such a case have to take into account also the locality.

17816. (*Chairman.*) Have you got any standard for the water round the oyster as well as for the oyster itself?—Well, we generally find this, that the water taken at ebb tide in a locality which is probably polluted or which is near an outfall contains bacillus coli communis and spores of enteritidis in a tenth of a c.c., and in a locality which is removed from a sewage outfall we find generally no bacillus coli in one c.c., from this we have come to consider that if bacillus coli communis is present in one cubic centimeter, and is not present in a one-tenth of a c.c., that would be the extreme limit. If it were present in one-tenth of a c.c., we should certainly condemn that water; we should say that water is polluted.

17817. (*Mr. Stafford.*) Have you examined the samples of the mud, or the gravel of the layings?—No, I have not. It is a fact that water which is within a mile or two of a sewer, would always show distinct indications of pollution, whereas water which is some distance away from sewer outfalls, tidal water, or water, for instance, at high tide would be free of it. Take, for instance, a place which is obviously polluted, like Bosham; you might examine a c.c. of water a mile or two away from the sewer, for bacillus coli, and you would not find it. It is only quite recently that I examined water from three localities, in Chichester Channel and Bosham Channel, and I could not find bacillus coli in one c.c.

17818. (*Chairman.*) If you found bacillus coli in one-tenth of the water, and there was no sewer within five or six miles, what should you say there?—Well, if I came across such a case, I should have to consider where it came from. I do not know whether there is such a case.

17819. But such a case might occur in the neighbourhood of cattle, might it not?—Yes, certainly, if you take a stream coming down from a meadow, you would very likely find bacillus coli in its waters; but I have not been referring to waters coming down from meadows. I am only speaking of waters from oyster layings.

17820. (*Mr. Stafford.*) Does sea water affect the vitality of the bacillus coli communis?—I think it does. I think it depends also upon the locality. I have found such an one near the Isle of Wight, for instance. The detection of coli in the water of that locality is much more difficult, though there is a sewer not very far; much more difficult than, for instance, in water near the south coast of England or the mouth of the Thames. It seems to me therefore probable that the sea water may have some deleterious effect on bacillus coli. It is the nature of the water, perhaps, where the ground—I mean the soil—has some influence, that is, whether it can or cannot affect the bacillus coli. I know that in the water that I got from very near the shore of the Isle of Wight, it was extremely difficult to find any bacillus coli, whereas there is no difficulty whatever if you examine the water from similar places or corresponding places, say, near the Mumbles, or other parts of the South Coast.

17821. Has that anything to do with the temperature of the water?—I would not like to say so. No, I do not think it has.

17822. What would you ascribe it to?—I think it is dependent on the nature of the material that it takes up from the soil; at any rate, that is merely a theory. I have no other facts beyond those mentioned, viz., that in water in one locality it seems very difficult to find bacillus coli, though it must have got into it.

17823. Do you think there is much bacillus coli communis in the layings of those oysters in the mud and sand? Is it likely to deposit?—I do not think so. No; I have really no data. I have not examined the ground, the earth or the soil, the mud from oyster layings.

17824. (*Colonel Harding.*) But in cases where there is obviously sewage contamination, I understood you to say that you had in certain cases not found bacillus coli in one c.c.?—Yes, I will give you the exact instance.

17825. Then it would seem in that case that one would have to rely more upon topographical conditions than upon bacteriological investigation?—I myself should rely just as much upon the bacteriological examination as upon the locality.

17826. This is rather an important point. You mentioned Bosham, I think, did you not?—I did mention Bosham.

17827. And you mentioned that there was obviously sewage contamination there?—Yes.

17828. And nevertheless you had not found bacillus coli in one c.c. Would that be in the oyster fluids or in the water?—In the water. I will give you the exact details as soon as I find the corresponding map.

17829. I do not think we need trouble you to find it. You know their locality?—I wanted to say I have examined three samples of water.

17830. What is the number of the map?—The map is No. 20. Oysters were taken from here, from here, and from here (*indicating on map*), and also water samples. Well, now, the oysters from here were distinctly polluted six out of eleven: two contained the bacillus coli communis, two others contained an organism, which only in one single test was not bacillus coli communis, but in all others it was; two further oysters contained a microbe, which in another single respect was not, but in all others it

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was bacillus coli communis. Here, then, we had distinct pollution of the oysters, and yet I could not find bacillus coli communis in one c.c. of the water. Then at half ebb, I think it was, the water from here (*indicating another locality*) we found bacillus coli in one c.c.; this (*another locality*) had not, and this (*showing on map*) had not.

17831. But does the sewage of Chichester pass the point *b* ?—Oh, yes.

17832. Oh! but you do not find one in a c.c. here?—No. You see the water is a changeable thing; the oyster is not.

17833. You said on the ebb, did you not?—The water constantly changes at every tide; the oyster does not. The oyster, perhaps, catches and retains things that the water had previously brought to it.

17834. The point I was trying to get at was how far the presence of bacillus coli could be permissible in an oyster at all?—We could not find any bacillus coli here in the water, although we found it in the oyster.

17835. Notwithstanding all those sewage outlets, there was no bacillus coli?—No. I understand there is not so much pollution now. We could not find any in the Isle of Wight. Here both water and oysters are clean (*showing the locality on the map*), perfectly clean, oysters and water too. From this it follows that there is a contrast between this locality and the south coast.

17836. Am I right in understanding that you think, in subjecting oysters for bacteriological investigations, we are to be guided rather by the proportion of the oysters that are contaminated at all, and not so much by the amount of the contamination in a particular oyster?—That is so, because it is liable to constant alteration. As regards sewage contamination in water, you ought to take into account not the absolute but the relative amount.

17837. (*Mr. Stafford.*) You do not condemn a sample then of oysters unless you apply all your tests?—I do not condemn any, as a matter of fact.

17838. But you do not certify that it contains bacillus coli communis?—I do not certify anything. I beg the Commission to understand I only examine oysters and give the result of my examination; whether the oysters are condemned or not is not my business, unless I am specially asked to do so.

17839. Quite so; I mean by condemned, you certify that they contain the bacillus coli communis?—That I do.

17840. You do not certify that they contain bacillus coli communis unless they answer all your tests?—That is so.

17841. You do not rely upon any one test?—No, no, no. I have given the essence of the tests in that paper that I published in the "British Medical Journal." and now incorporated in my evidence. (*See* paper, entitled, "The Bacterioscopic Diagnosis of Sewage Pollution of Shellfish.")

SIXTIETH DAY.

Wednesday, 10th June 1903.

PRESENT:

The Right Honourable The Earl of Iddesleigh (*Chairman*), presiding.

Sir Michael Foster, K.C.B., F.R.S., M.P.
Sir William Ramsay, K.C.B., F.R.S.
Major-General Constantine Phipps Carey, C.B., R.E.
Mr. W. H. Power, C.B., F.R.S.
Colonel T. W. Harding, J.P.
Mr. T. J. Stafford, F.R.C.S.I.

Mr. F. J. Willis, *Secretary*.

ALSO PRESENT:

Dr. A. C. Houston, M.D.

Dr. J. Niven.
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Dr. James Niven, Medical Officer of Health, Manchester, called; and Examined.

17843. (*Chairman.*) You are Dr. Niven, the Medical Officer of Health of Manchester?—Yes.

17844. Will you tell us if in your opinion shell fish can be contaminated and prove injurious to human beings, and give us your experience on the question?—A. The survey of the grounds belonging to British companies made by Dr. Bulstrode, and published in the Report of the Medical Officer to the Local Government Board for 1896, shows that no small portion of the oyster layings, fattening and storage tanks, are exposed to gross contamination by sewage. It is therefore certain that the infection of enteric fever will find its way into the oysters, and adhere to their substance in greater or less amount according to the amount of enteric excreta entering the sewers. In any case, the shells and oysters will be contaminated with fœcal matter.

B. In certain instances well-marked outbreaks of enteric fever have been traced to the consumption of oysters taken from contaminated layings, etc.; as, *e.g.*,

- Professor Coun's outbreak in Wesleyan College.
- The outbreak at Brightlingsea, invested by Dr. Buchanan.
- The occurrences of enteric fever at Southampton, Portsmouth, and Winchester in 1902.

C. It is but rarely that the contamination with specific infection will be so concentrated as to cause a number of cases clearly traceable to one laying. Rather these occurrences will be separated, and not easy to connect. Nevertheless, occasionally circumstances point very clearly to a specific source, as, for example, a series of cases in Blackpool in 1897, ascribed by Dr. Jasper Anderson, then Medical Officer of Health for that town, to mussels taken from the pier. Three cases occurring in one district in Manchester in 1900, and ascribed to a particular bed of mussels, and five cases in 1902 from one shop receiving mussels from the same source. Generally, however, such occurrences are likely to be more isolated, and these isolated occurrences will be submitted to examination.

D. The experimental investigations carried on by Dr. Klein and by Professors Boyce and Herdman go to show that—

- The typhoid bacillus remains visable in sea water for at least three weeks.
- It is recoverable from the interior of oysters for nearly that period, when they have been exposed to continuous infection.
- It flourishes on dead oysters, and, therefore, presumably on sick oysters, a circumstance which is probably of importance in connection with oysters or other shell fish lying on contaminated foreshores.
- Healthy oysters appear to have a destructive action on the bacillus.

E. It follows that the greatest risk is in connection with oysters from contaminated British layings, which are consumed within two or three days of their removal from the layings.

F. The next greatest risk will be in connection with oysters imported direct, and consumed without relaying. But, as regards these, inasmuch as the bacillus does not multiply under 20° C., as the healthy oyster appears to have a destructive action on the bacillus, and as these oysters can only be imported direct during cold weather, the risk is less. It is greater the nearer the source from which the foreign oyster is obtained.

Further distinct outbreaks traced so far have been in connection with the shell fish obtained from polluted British beds. But I should not like to infer that less concentrated occurrences of enteric fever might not happen in connection with oysters imported direct without relaying.

Having regard to the above considerations, I endeavoured to ascertain from what sources the shell fish used in Manchester are derived, and the extent to which shell fish are consumed.

The impression which I have received is that a large proportion of the oysters consumed in Manchester during the colder months are imported direct without relaying, are for the most part American, and are obtained in Liverpool, where they are landed, or to a less extent from Southampton. They are partly (it is said) purchased by the larger merchants, and are distributed to shops; partly inferior qualities are purchased by smaller dealers, and are sold largely to hawkers. But a large quantity of American oysters is also put down in British layings in spring to be dredged up as required for the market during the warmer months. Oysters are also imported direct from Holland, and are obtained from France for relaying. I am led to suppose that the oysters which have been relaid have come largely from pure waters, but there is no certainty on this point, and one would suppose that they would not all come from pure sources. In fact, Brightlingsea is said to be one of the sources of supply. Still, the best class of oysters do, no doubt, very largely come from the best British waters.

As regards mussels, these are obtained from Park Gate Chester, Ulverston, Boston, and Lynn, and from a number of places on the Irish and Scotch Coasts. Large quantities have also come from Conway, Wales.

It is not necessary to consider other shell fish, as they are not materially implicated by our inquiries. Further information as to the sources of supply are given in Appendix A, being information furnished by Mr. Holburn, the Chief Markets Inspector. The information which I have obtained as regards the extent to which shell fish are consumed is very imperfect. It is given in Appendix B in summary.

Results of analysis of the information collected in Manchester as to the connection between consumption of shell fish and the occurrence of enteric fever.

It is possible to give some figures as to the occurrence of enteric fever cases occurring in connection with shell fish in Manchester for these reasons. The cases of fever have been submitted to the serum test, and we know that we are dealing with enteric fever, and not with conditions such as enteritis simulating it. A record has been made since 1897 of all cases in which the attack has been associated with the consumption of shell fish. Unfortunately, in a number of cases, the time at which the shell fish was consumed has not been precisely recorded, nor has the particular kind of shell fish consumed been always stated. In a rigorous examination these cases have to be rejected. In determining in what cases shell fish could have caused enteric fever, the possible period between consumption and the appearance of symptoms has been taken at from six days to a month.

Only raw shell fish have been considered in the more rigorous test. But cases have not been rejected because only one member of a family partaking has suffered. Owing to gaps in the record, the number of attacks due to shell fish is probably under-stated. The figures are:—

——	Total Enteric attacks.	Cases assosciated with the consumption of shell-fish.	Cases which may strictly be due to oysters.	Cases which may strictly be due to mussels.	Total strictly ascribable to mussels and oysters.
1897 - - - - - - -	503	40	7	10	16
1898 - - - - - - -	642	74	16	17	28
1899 - - - - - - -	381	35	6	9	15
1900 - - - - - - -	381	38	8	14	17
1901 - - - - - - -	359	41	9	3	11
1902* - - - - - - -	378	46	6	26	31

* In this year five cases were ascribed to cockles.

Although partly from imperfection in the details ascertained, the proportion of cases is small in which the consumption of shell fish would seem to have led to the occurrence of enteric fever, there should, at least occasionally, be duplicate occurrences of the disease amongst persons eating shell fish together. No such duplicate occurrence is registered in 1897. In 1896 a friend who partook of mussels in Blackpool at the same time as one of the cases, died 35 days after, but it is not stated that the cause of death was enteric fever. In 1899 a brother and sister who ate raw mussels both developed enteric fever. In another instance also a brother and sister both had enteric fever after partaking of raw mussels. In another instance in which a family partook of cooked mussels two others suffered from suspicious illness. In a fourth instance the wife of the patient who also partook of raw mussels was ill for a week before him with a suspicious illness. In 1900 no duplicate occurrence is registered. In 1901 a father and son both suffered from enteric after consuming raw mussels. In another instance two companions partook of raw mussels, and one began to be ill with enteric a fortnight, the other three weeks after. In 1902 two friends partook of raw mussels together, and one began with enteric six days, the other eight to 14 days after.

There are, therefore, clear indications of the production of enteric fever by shell fish from this point of view. But these have reference entirely to mussels, and in the last instance it is known that mussels were purchased at a shop which the two friends visited, at which in the middle of 1902 mussels were obtained from the suspicious source already mentioned as probably having produced enteric fever in 1900 and 1902.

It would appear, then, having regard to the aggregate figures and to the facts just given, that mussels have been a more potent source of enteric fever in Manchester than oysters, and it is not unlikely that the contaminated mussels have mostly come from one source.

When, further, we scan either the cases associated with the consumption of shell fish, or those which have been ascertained to stand in a possible relation to shell fish of effect to cause, week by week, we perceive that there is usually a marked diminution or absence of such cases up to the end of August, and that the autumnal increase of enteric fever precedes the increase in cases ascribable to shell fish.

Now there is, no doubt, a considerable consumption of shell fish going on during the summer, as regards oysters largely or entirely of American and Dutch origin laid in British waters in the spring, mainly the former. Hence contaminated shell fish are not the cause of the autumnal increase of enteric fever in Manchester.

That this is so is further indicated by the fact that these cases extend into the earlier months of the year.

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TABLE showing week by week all cases of Enteric Fever beginning in that week, and cases which associated with

1897.

—	January	February	March	April	May	June
	9 16 23 30	6 13 20 27	6 13 20 27	3 10 17 24	1 8 15 22 29	5 12 19 26
All cases - - - -	10 10 7 5	10 5 8 7	11 6 8 6	4 5 10 3	2 3 5 3 9	1 4 3 3
Connected with shellfish -	2 0 1 1	0 1 1 0	0 1 1 0	0 0 1 0	—	—
Ascribable to oysters- -	0 0 1? 1	—	0 0 1 0	—	—	—
Ascribable to mussels -	0 0 1? 0	0 0 1 0	—	—	—	—
Ascribable to cockles, &c. -	—	—	—	—	—	—

1898.

—	January	February	March	April	May	June
	8 15 22 29	5 12 19 26	5 12 19 26	2 9 16 23 30	7 14 21 28	4 11 18 25
Total Number - - -	13 12 19 14	12 12 9 15	12 9 8 2	6 9 10 14 10	11 4 2 1	3 6 4 1
Connected with shellfish -	0 1 3 1	—	0 1 0 0	0 1 1 1 0	—	—
Ascribable to oysters -	0 0 1 0	—	0 1 1 0	0 0 0 1 0	—	—
Ascribable to mussels -	0 1 2 1	—	—	1 0 0 0 0	—	—
Ascribable to cockles, &c.	—	—	—	—	—	—

1899.

—	January	February	March	April	May	June
	7 14 21 28	4 11 18 25	4 11 18 25	1 8 15 22 29	6 13 20 27	3 10 17 24
All cases - - - -	12 14 16 12	5 9 6 5	3 5 6 3	5 7 6 7 10	3 1 6 4	6 3 4 4
Connected with shellfish -	1 2 1 2	1 0 1 2	—	0 1 1 0 1	1 0 0 0	—
Ascribable to oysters -	0 0 0 1	—	—	—	—	—
Ascribable to mussels -	0 1 1 0	0 0 1 1	—	0 1 0 0 0	—	—
Ascribable to cockles, &c.	—	—	—	—	—	—

1900.

—	January	February	March	April	May	June
	6 13 20 27	3 10 17 24	3 10 17 24 31	7 14 21 28	5 12 19 26	2 9 16 23 30
All cases - - - -	10 8 11 3	8 7 9 2	5 8 9 2 4	1 2 7 3	5 3 2 2	3 3 10 7 12
Connected with shellfish -	2 1 1 3	0 1 0 1	1 0 0 1 1	0 2 2 0	1 1 0 0	0 1 0 1 0
Ascribable to oysters -	—	—	—	0 1? 1? 0	—	0 0 0 1 0
Ascribable to mussels -	0 0 0 1	—	1? 0 0 0 0	0 1? 1? 0	1 1 0 0	—
Ascribable to cockles, &c.	—	—	—	—	—	—

1901.

—	January	February	March	April	May	June
	5 12 19 26	2 9 16 23	2 9 16 23 30	6 13 20 27	4 11 18 25	1 8 15 22 29
All cases - - - -	4 3 3 3	3 5 4 0	4 2 2 4 6	2 8 2 6	2 4 1 2	1 5 6 3 2
Connected with shellfish -	—	0 1 0 0	0 0 0 1 2	0 2 0 1	—	0 0 2 0 0
Ascribable to oysters -	—	—	—	—	—	0 0 1 0 0
Ascribable to mussels -	—	—	—	—	—	—
Ascribable to cockles, &c. -	—	—	—	—	—	—

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stand in association with shellfish, as well as those which the ascertained facts show to be more intimately shellfish.

1897.

July 3 10 17 24 31	August 7 14 21 28	September 4 11 18 25	October 2 9 16 23 30	November 6 13 20 27	December 4 11 18 25	1898. January 1	—
6 4 3 6 5	3 8 7 17	20 12 13 19	20 16 17 11 12	13 18 12 20	21 20 17 23	12	503
0 0 0 1 0	—	2 0 1 0	1 5 6 3 0	0 0 1 3	3 3 1 0	1	40
0 0 0 1 0	—	1 0 0 0	1 0 0 0 0	—	0 0 1 0	—	—
—	—	0 1 2 3	—	—	1 0 0 0	1	16
—	—	—	—	—	—	—	—

1898.

July 2 9 16 23 30	August 6 13 20 27	September 3 10 17 24	October 1 8 15 22 29	November 5 12 19 26	December 3 10 17 24 31	—
4 1 7 4 4	6 7 8 7	23 15 13 18	21 28 39 31 30	21 10 20 17	20 20 18 14 18	642
1 0 0 0 0	0 0 2 0	2 0 4 5	2 3 2 4 4	5 4 4 6	8 1 2 1 4	74
1? 0 0 0 0	0 0 1 0	2 0 1? 1?	0 0 1 0 0	1 0 0 0	2 0 0 0 2?	28
1? 0 0 0 0	—	0 0 1? 1?	—	2 2 1 1	0 0 0 1 2?	—
—	—	—	—	—	—	—

1899.

July 1 8 15 22 29	August 5 12 19 26	September 2 9 16 23 30	October 7 14 21 28	November 4 11 18 25	December 2 9 16 23 30	—
5 2 0 2 5	5 5 15 11	12 10 12 10 15	12 6 9 7	10 8 9 10	9 10 4 7 9	381
—	0 0 1 3	0 0 0 2 0	1 0 1 1	1 2 0 2	2 3 2 0 0	35
—	0 0 1 2	—	—	—	0 1 1 0 0	15
—	—	—	1? 0 0 1	—	2 0 0 0 0	—
—	—	—	—	—	—	—

1900.

July 7 14 21 28	August 4 11 18 25	September 1 8 15 22 29	October 6 13 20 27	November 3 10 17 24	December 1 8 15 22 29	—
18 12 11 8	8 7 3 5	1 5 6 4 6	14 5 5 8	5 5 10 10	10 8 4 7 6	381
0 0 0 1	0 2 0 0	3 0 0 2 2	2 1 0 1	0 0 1 1	0 1 1 0 0	38
—	0 1? 0 0	1 0 0 0 1	—	0 0 1? 1?	—	17
0 0 0 1	9 1? 0 0	1 0 0 1 0	—	0 0 1? 1?	0 1 1 0 0	—
—	—	—	—	—	—	—

1901.

July 6 13 20 27	August 3 10 17 24 31	September 7 14 21 28	October 5 12 19 26	November 2 9 16 23 30	December 7 14 21 28	—
1 2 3 7	13 15 13 12 13	22 14 20 14	17 27 11 15	9 9 9 6 7	3 6 2 3	359
0 0 1 1	0 1 0 0 1	1 1 5 1	2 2 3 2	1 3 0 0 2	0 3 1 1	41
—	0 0 0 0 1	0 0 0 1	1 0 1 0	1? 0 0 0 1	0 2 0 0	11
—	—	—	0 0 1 0	1? 0 0 0 0	0 0 0 1	—
—	—	—	—	—	—	—

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Table showing week by week all cases of Enteric Fever beginning in that week, and cases which stand in

1902.

	January				February				March					April				May					June			
	4	11	18	25	1	8	15	22	1	8	15	22	29	5	19	19	26	3	10	17	24	31	7	14	21	28
All cases - - - -	3	3	3	6	5	7	6	7	2	2	5	7	7	8	9	11	7	2	4	4	4	3	8	4	10	8
Connected with shellfish -	0	1	1	1	1	2	0	0	1	0	0	1	1	2	0	0	3	0	1	1	0	0	0	1	1	1
Ascribable to oysters -	—				—				0	0	0	0	1	0	0	0	1	0	0	1	0	0	—			
Ascribable to mussels -	0	1	0	1	1	1	0	0	1	0	0	0	0	1	0	0	2	0	1	0	0	0	0	0	1	1
Ascribable to cockles, &c.	—				0	1	0	0	—					—				—					0	1	0	0

APPENDIX A.

SHELL FISH SUPPLIES.

From information gathered, Manchester Market receives its supplies from the following places :—

Oysters, re-bedded.

Brightlingsea, Essex.
Cleethorpe, Lincolnshire.
Fleetwood, Lancashire.
Beaumaris, Anglesey.
Londonderry, Ireland.
Warrenpoint, Ireland.
Carlingford, Ireland.
Malahide, Dublin?
Sutton, Dublin?

Oysters, Natives.

American.
Dutch.
Portuguese.
Whitstable.
Colchester.
Dublin.

MUSSELS.

Kirkcudbright, Creetown, } Solway.
Morecambe, Glasson Dock, Fleetwood, Askam-in-Furness, Cark, Ulverston, } Lancashire.
King's Lynn, Norfolk.
Boston, Lincolnshire.
Lymstone, Devonshire.
Hoylake, West Kirby, } Cheshire, Dee.
Connahs Quay, Parkgate Neston, Flint, } Mouth of Dee.

Conway, North Wales.
Barmouth, Aberdovey, } Cardigan Bay.
Londonderry, Ireland.
Belfast, Dundalk, Omeath, Warrenpoint, Carlingford, Drogheda, Cork, } East Coast.
Killorglin, Dingle Bay.

COCKLES.

Askam.
Ulverston.
Cark.

Lytham.
Borve.
Aber.

Parkgate.
Boston.
King's Lynn.

SHRIMPS AND PRAWNS.

Morecambe
Fleetwood.

Askam.
Cark.

Ulverston.
Southport.

King's Lynn
Boston.

The statutory closed time for deep sea or native oysters is between 15th day of June and the 4th of August.

The oysters consumed in the summer months are relaid American oysters.

The gathering of mussels in England and Wales is prohibited from April 30th to 1st of September. There is no closed time for mussels in Scotland or Ireland.

Very few mussels are sent to the market from May to September, what are sold are chiefly from Ireland. At the beginning of September the mussel season opens in full swing, and the best quality of mussels come from Connah's Quay, Aberdovey, Drogheda, Cork, and Creetown.

There is no closed time for cockles, and many fishmongers consider them at their best in May and June.

association with shellfish, as well as those which the ascertained facts show, &c.—*continued.*

1902.

July 5 12 19 26	August 2 9 16 23 30	September 6 13 20 27	October 4 11 18 25	November 1 8 15 22 29	December 6 13 20 27	1903. January 3	—
7 3 4 9	10 6 5 8 10	7 5 17 20	11 9 12 12	10 3 10 5 14	7 14 5 4	6	—
0 0 1 1	1 0 2 0 1	0 0 1 4	0 1 4 4	2 0 1 0 1	0 2 1 0	—	378
—	0 0 1 0 0	—	—	0 0 0 0 1	0 1 0 0	—	56
0 0 1 1	0 0 0 0 1	0 0 1 3	0 0 1 3	0 0 0 0 1	0 1 1 0	—	36
—	1 0 1 0 0	—	..	1 0 0 0 0	—	—	—

The amount of shell fish condemned during the five years, 1898 to 1902, is estimated in the following figures:—

—	Oysters.	Mussels.	Cockles.	Crabs.	Lobsters.	Shrimps.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1898	566	74,770	20,414	1,072	224	3,416
1899	854	14,792	4,816	1,568	100	2,334
1900	672	10,766	9,744	890	28	4,411
1901	672	15,680	9,836	3,362	104	3,238
1902	112	19,794	8,050	733	21	2,060
	2,876	136,802	52,860	8,125	477	15,459

The state of the weather, condition of the trade, and abundance of supplies, go to account for the amounts condemned.

The large quantity of mussels condemned in the year 1898 is accounted for by overstocking the market at the commencement of the season (September and October) and bad weather.

There is no great difficulty in judging the soundness of shell fish as to decomposition.

First.—We have the live fish, which can only be opened with difficulty, and, when opened, contains an amount of liquor, and is agreeable in smell, taste, and colour.

Second.—The shell fish begins to show signs of weakness by way of opening the shell and closing, and also loses its surface moisture (becoming sickly). At the time they begin to open and close they should be used at once.

Third.—When the fish is too weak to close its shell it is either at the point of death or dead, and is condemned.

Of course, some fish are better nourished than others; for instance, the mussels from Aberdovey and Parkgate are better than those from Conway, Barmouth, or Morecombe.

From the books it is clear that most mussels are condemned at the beginning of the season, especially if we have bad keeping weather in September and October, and we also have big lots sometimes in April towards the close of the season.

We do not condemn any great quantity of oysters.

Shrimps and prawns are chiefly condemned between June and September.

The whole of the shell fish is practically condemned at the fish market, there being only small quantities condemned in shops.

Alfred Holburn.

APPENDIX B.

On the Quantity of Shell Fish Used.

As regards the quantity of cockles and mussels consumed in Manchester, I am informed that from September to Christmas 500 to 1,000 bags are imported daily, each bag averaging 1 cwt.; from Christmas to April half that quantity. Cockles continue during the summer. In winter 500 to 1,000 barrels of American oysters are imported weekly, each barrel containing 500 to 1,000 oysters. Of this quantity, Manchester takes perhaps one-third. It is not possible to estimate the quantity brought in from native beds.

The beds from which the home mussels and relaid mussels are obtained are given in Mr. Holburn's statement, Appendix A.

It will be seen that some of these are open to contamination, as, *e.g.*, oysters laid at Brightlingsea, Cleethorpe, Beaumaris, and mussels in the Dee and from Conway. It is claimed for the East River and Blue Point American oysters that they are obtained from uncontaminated deep sea waters, and the London and Manchester Oyster Co. have their layings in deep sea water in Loch Ryan.

As regards the extent to which shell fish (oysters and mussels) are consumed in Manchester, I have had inquiries made at 1,354 houses occupied mainly by people of the artisan class. Of these I find that shell fish (mostly oysters and mussels) were partaken of at some period of the year 1902 in 384. They were used raw at 90 houses, and cooked at 360. That these numbers do not add up to 384 is accounted for by the fact that at some houses they were used both raw and cooked. They were used frequently at 45 houses. The number of cases of enteric fever occurring at these houses in 1902 was stated to have been five, one where no shell fish was eaten, three where mussels were used at one or another time, and one where both mussels and oysters were used. These figures, as far as they go, point rather to mussels than oysters as sources of infection. The oysters consumed by these households would be mostly American, imported direct in cold weather and obtained from British layings in the warm months.

Dr. J. Niven.

10 June 1903.

17845. What remedies can you suggest?

May I premise that, as far as I can ascertain, a very great amount of harm has been inflicted on the traffic in shell fish, especially among the better class consumers, by recent occurrences, and that it is, therefore, necessary to take very decided action, such as will entirely reassure the public.

From what one can learn, it is not believed that the following proposals will affect the price of oysters, except that one which has reference to relaying imported oysters before consumption.

1. All layings, fattening and storage ponds for oysters, and all mussel beds used for market purposes, should be registered, and the register published.

2. All layings, fattening and storage beds from which shell fish are taken direct to the market, and which, in the opinion of the Local Government Board, are exposed to the risk of contamination with faecal matter, should be disused.

3. Except such diversion is effected of the sewage outfalls as, in the opinion of the Local Government Board, will remove all risk of contamination.

4. Where the risk of contamination is doubtful, the requirements of the case may be met if sewage, before being admitted into the waters containing the layings, is treated to the satisfaction of the Local Government Board, and if, further, no oysters are sent direct to the market without having been relaid in pure waters for at least a fortnight.

5. The medical officer of health of every district on the littoral of which layings, fattening, and storage ponds for oysters are situated, shall annually report to the Local Government Board on any risk of contamination to which these are exposed from the sewage of the district, and on the measures which, in his opinion, are necessary and practicable to ensure the protection of the layings; and the same shall apply to mussel beds.

6. When it shall appear to the medical officer of health of any district that enteric fever or other disease is being caused in his district by the consumption of shellfish, he shall report to the Local Government Board, stating the grounds on which he has arrived at his conclusion. If, in the opinion of the Local Government Board, such report presents reasonable grounds for suspicion, an inquiry shall be instituted by the Board, and such action taken thereupon as the circumstances appear to require.

7. The Local Government Board may, in the case of home fisheries, determine as between sanitary authorities and a company having layings, etc., on shores contaminated with sewage introduced by the authorities, whether it rests with the sanitary authorities to purify or divert their sewage, or whether the company must remove their layings, or what precautionary measures the respective parties must carry out, and may apportion the expenses to be incurred, and their decision shall be final.

8. In the case of consignments of shellfish from abroad, all such consignments must be deposited for a minimum period of fourteen days in deep sea water before being placed upon the market.

The effect of 8 would be to raise the price of the cheaper imported oysters. It is, however, necessary, while imposing stringent conditions on British fisheries, to guard against the possibility of diverting the oyster and other shellfish trade to foreign countries, so incurring the risk of importing contaminated shell fish, over which the sanitary authorities of the country would have no control.

17845A. What difficulties would you anticipate in carrying out the proposals made?

A.—It would be necessary to prevent the collection of mussels and oysters by hand from foreshores declared by the Local Government Board to be exposed to risk of contamination. This duty would properly be thrown upon the companies concerned, and on the sanitary authorities.

B.—How is the requirement that oysters must be laid in pure water for a sufficient time before being placed on the market to be enforced?

Companies should be required to produce to the Local Government Board evidence that they have secured layings, and, where storage is requisite, storage in positions free from risk of contamination.

To every purchaser of a consignment of oysters or mussels landed from a ship, steamboat, or fishing boat, should be handed by the chief officer a statement declaring that the consignment had been removed from pure sea water on..................................(date) at ...., indicating precisely the position of the laying.

By what other machinery this requirement is to be enforced I am unable to suggest, though doubtless some means could be suggested by those experienced in the business.

C.—It would not be so difficult to ensure that the cheaper foreign oysters deposited in spring for consumption during the warm months had been deposited in pure sea water.

D.—To require all imported oysters to lie a certain time in British waters, approved as free from risk of contamination, would add considerably to the cost of carriage and labour, and would increase the price of the cheaper qualities. But, if stringent conditions are to be imposed on British fisheries, this requirement appears requisite.

E.—Difficulties will present themselves in respect of the rights of companies to particular layings, and of sanitary authorities to the disposal of their sewage in tidal waters.

I have suggested that the Local Government Board should arbitrate as between the two.

In those instances in which it was deemed necessary by the Local Government Board to remove layings exposed to contamination, the question of compensation might have to be considered.

Of course, I quite understand there will be many practical difficulties other than those which I have mentioned.

17846. Have you anything to add to what you say about the difficulties; or, in fact, is there anything you wish to add?—Well, if I take the question how a requirement that oysters must be laid in pure water for a sufficient time before being placed on the market is to be enforced, of course there might be a good many answers to it. I presume that it would be possible to remove all oysters from any position in which they could possibly be gathered by hand—that would be a possible thing to do; and then there is also the question as to how one is to prevent oysters from being taken direct to the market from storage ponds in positions where they would be liable to contamination. It would be necessary to prohibit the use of storage ponds in positions liable to contamination.

17847. I see that you recommend that the Local Government Board should be placed in authority?—Yes, I think it is necessary to have some Central authority.

17848. Do you not think it would be desirable that that central authority should have special knowledge of this subject?—The reason that I mentioned the Local Government Board is that they have special knowledge upon the subject; that, so far as I know, they are the only authority who have made extensive investigations into the condition of the oyster and mussel layings in the country, and that they have already a very large store of knowledge upon the subject, and they are specially fitted to deal with it; that was my reason for mentioning the Local Government Board.

17849. I do not know whether you have seen any of our former reports?—I am afraid I have not.

17850. Well, we have recommended the creation of River Boards all over the country, and the creation of a supreme authority—probably a department of the Local Government Board?—I beg your pardon; I did not understand, I thought, the reports upon this particular subject of oysters.

17851. Oh, no?—Oh, yes, I have.

17852. Well, would you be disposed to think that the registration of shellfish could be entrusted to such an authority as we have suggested?—Yes, I should say so—the registration, certainly.

17853. (*Sir Michael Foster.*) By registration you mean registration of layings and storage pits which are free from contamination?—Registration of layings and storage pits, yes; and also the statement as to whether they were liable or not liable to contamination; that might safely be entrusted, I think, to the Rivers Boards.

17854. (*Chairman.*) With the supreme central authority behind them?—Yes, with the Local Government Board behind.

17855. You see our idea is that a vast amount of knowledge requires to be collected on all these subjects connected with pollution, and that practically that only can be obtained by one central authority; would you be disposed to agree with that?—By one central authority.

17856. The knowledge, in fact, can only be collected by a central authority?—By a central authority.

17857. The knowledge; the actual knowledge?—Well, I think the total knowledge should come into some central authority, which was entirely competent to deal with the sanitary aspect of the question. Yes, and I quite agree that Rivers Boards would amply fulfil the functions of registering the different fisheries and determine upon their liability to contamination. But the Local Government Board could fulfil these functions at the present time with the aid of sanitary authorities.

17858. The question of liability to contamination is, of course, an exceedingly obscure one, and if we ever get to the bottom of it it will only be after a very long time and after making many experiments?—That may be as regards the finer issues of the question, but as regards the condition of many of the deposits of shell-fish off our coast there seems to be no difficulty whatever in coming to a conclusion as to their exposure to serious contamination.

17859. And then?—And, no doubt, as regards minor and what one may call doubtful degrees of contamination, taking into account the total value of such fisheries, and the possible injury to health, I should say that stringency should err, if it can be called error, rather, on the side of a strict view of the possibilities of contamination than upon the other side. But, of course, the possibility of liability to contamination—these minor degrees of contamination would bring into question the best way of dealing with the sewage so as to diminish to the maximum extent the amount of infection existing in the sewage, and to disperse it in such a manner also as to render the danger minimal. That might very properly come primarily under River Boards.

17860. (*Sir Michael Foster.*) I gather then, Dr. Niven, while in the measures that you have suggested here you refer only to the Local Government Board and to the Medical Officer of Health, you are now, after the statement by the Chairman, prepared to assent to the control by a Rivers Board in the first instance?—In the first instance, yes; and on the supposition that the Rivers Boards to be appointed would cover the ground. At the same time, also, I see no reason why the registration of shell fish layings, etc., and questions affecting the treatment of the sewage should not now be undertaken by the Local Government Board, and subsequently become part of the duties of River Boards.

17861. Who should have complete control of all the fisheries in the district, and that from the Rivers Boards there should be an appeal to a central authority?—Yes, reference to the Local Government Board.

17862. Well, the central authority would be more or less, you see, naturally, a department, or would have some very close relations with the Local Government Board?—I think so; I think that as the question is one which entirely relates to the danger of infection of one kind or another, not altogether enteric, but also cholera and enteritis, and conditions of that nature, that such Boards ought to be in communication with, that their procedures ought to be placed before the Local Government Board; their procedures ought to be in the possession of the Local Government Board, and that in matters relating to infectious disease, that is to say, where a possibility of the spread of disease by shell-fish arises, that the Boards should be in communication with the Local Government Board, and should in certain cases make reference to the Local Government Board. So far as the keeping of a complete register is concerned, this must clearly be in the hands of the Central authority.

17863. With oysters the matter seems to a certain extent simple. I understand your view to be that with the proposed authority certain layings and storage pits should be registered as free from contamination, and therefore that the sale of oysters from these beds should be permitted, but that the sale of oysters from layings and storage pits, which were not registered should be forbidden?—Well, no. My object in recommending registration was to bring the whole of these layings and pits under consideration, and also to give the public the opportunity of knowing precisely where the shell fish came from.

Dr. J. Niven.

10 June 1903.

17864. Your registration would be simply a registration of their existence, and not of their quality, such as freedom from contamination, and so on?—I did not intend primarily that registration was to imply fitness; that was not the idea. As you say, it was simply of existence.

17865. But would not that be more or less a simple plan that where a laying and a storage pit had been carefully examined by the Rivers Board in the first place—possibly by the central authority afterwards—and ascertained to be free from contamination, that free sale of oysters from those layings and storage pits might be permitted, whereas in another case, where there was obvious contamination, where there was doubt, the sale of oysters from such pits should be rigorously prevented, and in every case where there was doubt the sale should be suspended until the matter was settled in one direction or another?—Yes, as regards grosser conditions no doubt that plan would——

17866. But not only as regards the grosser conditions, in regard to the problem generally, it being supposed that it is possible for scientific opinion to determine whether there is danger or not from a laying or a storage pit, and using the best scientific opinion in the country, such opinion being at the disposal of either the Rivers Board or the central authority?—Oh, from the point of view of the Medical Officer of Health, of course, assuming that that would be carried out pretty strictly, that the original determination would be carried out on the side somewhat of rigour, that would be the simpler and the more——

17867. But would it not be simpler to carry that out on the side of truth? I mean that the best possible examination having been made in order that the best judgment might be arrived at, the nation might trust to that judgment to say whether oysters from those layings or from that storage pit might be eaten with probable impunity?—Yes, it might.

17868. And that the public sale of oysters other than from these layings and storage pits should be prevented?—Yes; yes, no doubt. There is just this, that where doubt did exist there would be, I think, naturally a great disinclination to decline to put a fishery upon the register, when upon subsequent examination it might appear that it was in reality exposed to contamination. I do not wish to make too much of that, but that is how it would appear to me rather. However, substantially, it comes to the same thing, I think.

17869. (*Major-General Carey.*) Would it not be a better protection to the public to know whether the beds which were registered were as far as possible free from contamination?—Well, it would be more reassuring, I dare say, but the register could be subsequently purged.

17870. In your proposal, as I understand it—all beds are registered?—To commence with.

17871. All beds to commence with, and then you leave it to the public to find out which are the beds which are free from contamination, and which are not?—In the first place; but I also propose that beds exposed to gross contamination should be immediately disused.

17872. (*Sir Michael Foster.*) That is to say should not be registered?—Well, of course, they would be taken off. You see what strikes me is that if it is desirable that the conditions of these fisheries should be rapidly determined, possibly the best thing would be to make a register in the first place, and then to deal at more leisure with layings and ponds, and so forth, which are exposed to contamination; dealing first, of course, and at once with those which are exposed to gross contamination, whereas if it is a question of making a register, and rejecting those which are not suitable, I should imagine that that would take a considerable time, and meantime the uneasiness as to the condition of our fisheries would continue.

17873. Do you not think present knowledge is sufficient to show that certain layings and certain storage pits may be registered at once as layings and pits from which oysters may be eaten; that a certain number would be condemned at once as unfit and dangerous, and that a certain other number would have to be subjected to more examination than they had yet been subjected to, in order to ascertain whether they should be registered as fit for use or not?—You are considering what I have proposed now; is that your question?

17874. No, I am asking you. You were saying it would take so much time?—To make an expurged register.

17875. Yes; is there not a very large amount of knowledge in our possession?—There is a very large amount of knowledge in our possession.

17876. So that at all events a very large start might be made on the one hand with layings and storage pits which were either absolutely fit or unfit, with a certain class which would require further examination?—Yes, that is so; that is so, certainly.

17877. I see you recommend that all imported oysters should be put into pure water first?—Yes.

17878. Is it not the case that the American oysters come with a certificate that they are taken from uncontaminated sources?—Yes.

17879. On the Long Island and Jersey?—Yes, I believe so.

17880. Cannot that be trusted?—I do not know.

17881. I believe that the oysters from Long Island and another place which are shipped in very large quantities to Liverpool are taken from places which bear the definite Government certificate, but I think it is the State in America—that those layings are free from all contamination. It is unnecessary to subject those to fresh laying in pure water in England?—I think it is desirable; that is my opinion. I am informed that the condition of the oysters is improved on relaying in that manner—as a matter of the value of the shell fish.

17882. That suggestion was made in a Bill which was laid before the House of Lords, in 1899, I think it was?—I quite perceive the difficulty about the American oysters, but I do not see, if you are going to make any restriction of that kind at all, how you can properly distinguish between oysters imported from Long Island and oysters imported from elsewhere; that is my difficulty. And I think it would be proper that while imposing restrictions upon our own fisheries security should be taken that oysters from abroad should be relaid in pure sea water before being used, the more so as I am assured that the condition of the oysters is thereby bettered.

17883. And the carrying out of that you would intrust to the Rivers Boards and the central authorities?—Oh, yes; yes, I would.

17884. Would you not let fisheries committees intervene—the various fishery committees on the coast?—You will remember in the Bill which was laid before the House of Lords, that came to grief because the committee of the House of Lords changed the authority from the sanitary authorities to the fishery committees?—I think if you were creating the Rivers Boards to deal with this question, it is desirable that they should take the whole matter in hand, certainly.

17885. Well, your plans might answer with oysters, and, to a certain extent, with mussels, which are cultivated in beds, and so on, but how are you to prevent the cockles, which are disseminated widely?—I should not deal with them; I do not think the thing is of sufficient importance and magnitude to deal with.

17886. Oysters and laid mussels; you think legislation with regard to those would be adequate?—Yes.

17887. (*Major-General Carey.*) Referring to the cases of enteric fever which you have supplied; how do you differentiate between the cases ascribed to the consumption of shellfish—oysters, mussels, cockles—and ordinary cases?—Well, a sanitary inspector is furnished with a form of inquiry, in which every case of enteric fever which he visits, and one of the questions upon that form is this: "Has the patient, between two and three weeks before the commencement of his illness, consumed shellfish—oysters or mussels—and whether they are raw or cooked?" That he answers upon the form, and in many cases he states precisely the date at which the shellfish has been consumed, and what is the particular shellfish which has been used, stating also whether other members of the family have also suffered from enteric fever. It is upon those forms that this information is based. In mentioning those more decidedly ascribable to shellfish I have used only those forms in which the interval—the precise interval—is given between the consumption of the shellfish and the commencement of symptoms.

17888. But in some cases, of course, the interval between the consumption of the shellfish and the actual date of the illness varies?—Oh, yes.

17889. It is not a fixed period of incubation?—If it is less than six days I reject the case altogether, and if it is over a month I reject the case altogether, as having a connection—as being ascribable to the shellfish. I have given three forms here, those which are in association with shellfish, and those which are more properly ascribable to the consumption of oysters, and those which are more properly ascribed to the consumption of mussels. In those cases the dates are such as would allow of the attack being due to the consumption of the shellfish named, and also all cases are rejected from this list in which any other source of the disease was ascertained. They could only be ascribed to oysters or mussels so far as we knew. Of course, it does not follow that they may not have owned some other source of infection, but this was the only source of infection ascertained.

17890. That was probable?—Well, it was the only source ascertained which could have given rise to the attack of enteric. As I say it does not follow from that that they were actually due to the consumption of shellfish, but it was the only source possible that we ascertained. I do not wish to imply that every case given here—I have given a summary of this table in which, in 1897, it appears that 16 were more properly ascribable to mussels and oysters; in 1898 28 out of 642, and so at 1902, 31—I do not mean to say that each of those 16, 28, and 31, were certainly due to the consumption of shellfish, but only that no other source was ascertained, and that the dates were compatible with the consumption of the shellfish having caused the attack of the enteric fever.

17891. (*Colonel Harding.*) Was no inquiry made in those cases as to possible other causes?—Oh, yes; a full inquiry is made in each case of all possible sources.

17892. Are we to understand that in those cases which you attribute to shell fish there were not insanitary condition—in the dwellings for instance?—Nothing—well, there might be.

17893. Was not inquiry made?—Yes, certainly, but without going through the forms I cannot tell you the details; but I can say that no proper source of the disease was found, and a general insanitary condition will not cause enteric fever.

17894. So far as you can tell, they were directly ascribable to the consumption of shell fish?—They were not ascribable so far as we could ascertain to anything else. They were ascribable; I do not say they were due absolutely—to go to that extent would be going too far, I think.

17895. Then in those cases did you trace the source of the supply of the shell fish which were supposed to have caused the enteric fever?—Generally, no.

17896. In some cases you did?—In some cases we did.

17897. Did you discover impure conditions in the layings?—In the shell fish?

17898. Yes?—We found in one instance, in 1900, as I have explained, that three cases were due very probably—you might almost say were due—to the consumption of mussels, and that last year five cases, in a limited area, were due to the consumption of mussels from the same source as the three in 1900.

17899. And were you able to trace any source of danger in the layings of these mussels, proximity of drains?—I wrote to the medical officer of the district in which the mussels were laid—these mussels were laid at the mouth of a river in Wales—and he informed me that the sewage of a number of villages on the river drained into the river, and was carried over the mussel beds. I think that in that particular instance I should go so far as to say that I should ascribe—distinctly ascribe—the enteric fever noted to the consumption of those mussels. Of course, one has to treat this matter with strictness. In every case that I have found that two persons consuming the same mussels have subsequently at a date, which would allow of their having been infected by the mussels, contracted enteric fever. I have mentioned those instances in this statement, and although the evidence as regards oysters is not convincing—it is not very strong—yet as regards mussels, I think that the evidence is tolerably conclusive.

17900. (*Mr. Stafford.*) Have you any experience of the conditions of any of the beds, either mussel beds or oyster beds?—No.

17901. From which Manchester is supplied?—No; I do not know the conditions personally. It is quite true that I have been to Cleethorpe, and have seen the beds, but I have no such knowledge—no knowledge that would be of any value.

17902. Have you any knowledge of the places in which the oysters or mussels are stored by the retail merchants?—No; no, I have no practical knowledge on the subject.

17903. Are they stored in Manchester before they are consumed?—I think not.

17904. I suppose the Manchester merchant would have to keep them for some little time before he could get rid of them?—I think not; I think a very large amount of the shellfish used in Manchester is bought in the Liverpool market, and is brought over and distributed directly. I am not aware, at all events, of any such storage in Manchester.

17905. Are the mussels hawked in the streets? Are they brought round by hawkers?—Well, they are partly sold in the markets and partly they are sold in shops and partly by hawkers.

17906. But these hawkers do not get rid of their whole store in one day or two days or three days? They must have some method of storing them, must they not?—Possibly. I am told, however, that the best way to store these shell fish is to put them in a cool place and cover them with a moist cloth; that it is not a good way to store them to place them actually in water.

17907. They must be stored; they must not be open to pollution in the retailers' shops or storage pits, if they have such things?—Well, I do not know that there is any reason to suppose that they are so exposed to pollution.

17908. But you might have your oyster beds and you might have your mussel beds quite clean, and if you do not have some means of dealing with the retailer you might still have pollution of the mussels or oysters and disease arising from them?—I think that is quite an infinitesimal danger. I think the chances are that, where they are stored at all, they are simply covered over with a wet cloth and the shells are closed. I think that is not a real danger.

17909. You think it is a very small danger?—I think it is not a real danger.

17910. With regard to the specific pollution that you allude to, do you consider it essential that there should be specific pollution by typhoid excreta in order to produce enteric fever?—Oh, yes, certainly.

17911. The presence, therefore, of bacillus coli communis or enteritidis sporogenes, either collectively or separately, would not itself be a proof that shell fish contained organisms capable of producing enteric fever?—Oh, no. I almost think it would prove that the shell fish had been exposed to fæcal contamination, but that would be quite sufficient for practical purposes. If they are exposed to fæcal contamination, they are exposed to risk of the specific infection of enteric fever; that follows, of course.

17912. Yes, but they are only exposed to the risk of it?—Still, that is enough.

17913. The amount of coli must be very largely in excess of the amount of the bacillus typhosis?—Well, it is as matter of fact. Where you have clear proof of fæcal contamination, whether bacteriological or better by direct inspection, that is quite sufficient, I think, for practical purposes.

17914. It indicates the danger?—Yes; I think it is sufficient for practical purposes. You would not use drinking water which had been shown to be exposed to the risk of fæcal contamination.

17915. No?—You would know that such water was liable at one time or another to produce an outbreak of enteric fever.

17916. You think that the enteritidis sporogenes is proof of certain fæcal pollution?—I am not a bacteriologist; there is a good deal of difference of opinion as to the precise bacilli which causes enteritis and diarrhœa, but certainly bacilli of that character, whether it is enteritidis sporogenes or whether it is allied bacilli of the same group, no doubt do indicate fæcal contamination.

17917. You do not think you would find it in ordinary mud?—You would not find it in ordinary mud.

17918. Which had not been open to fæcal pollution?—I should imagine not; I do not know as a matter of fact. As far as I am aware—that is not my special work—but as far as I know, there would be no difficulty from the examination of the various organisms occurring in shell fish to ascertain whether it had been exposed to fæcal contamination. There are two or three separate organisms which occur as the result of fæcal contamination; bacillus coli is one.

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17919. But may you not find coli in pure sea water?—I do not know these matters personally; I am not a bacteriologist, as I have said; I can only take the evidence of Dr. Klein, that he did not find any of these organisms where there was no fæcal pollution.

17920. I suppose bacillus typhosus has not been discovered in any of the outbreaks you refer to: Professor Conn's outbreak in Wesleyan College, the outbreak at Brightlingsea investigated by Dr. Buchanan, or the occurrences of enteric fever at Southampton, Portsmouth, and Winchester in 1902?—The bacillus typhosus was not found.

17921. The bacillus typhosus has not been in any of those cases, I suppose, demonstrated?—I am not aware. So far as I remember the scientific evidence, the bacillus of enteric fever was found in one instance in some oysters from Grimsby, in the course of Dr. Klein's investigation, but I am not aware of any other instance in which it has been demonstrated in oysters from a suspicious source. I do not know the full investigations with regard to the Emsworth outbreak; I can only take the public reports upon that subject.

17922. You would sooner follow Dr. Klein, Professor Boyce, and Professor Herdman with regard to these matters?—Yes.

17923. Because you quote them here to the effect, "That the healthy oyster seems to exercise a power of destruction upon bacillus typhosus"?—

17924-5. I want to know what you refer to there?—To the investigations of Dr. Klein as to the bacillus of enteric fever. I merely quote that in order to arrive at some sort of idea as to what was the relative danger of oysters taken direct from our own polluted layings and oysters carried over in cold weather from foreign countries.

17926. You know nothing personally as to how these investigations have been arrived at?—Oh, yes; I have read some account of the investigations. I know that the conclusions of Professors Boyce and Herdman were arrived at by inoculating cultures of enteric fever in oysters and ascertaining what was the number of bacilli ascertained at different distances of time after the inoculations. They found that the bacillus of enteric fever diminished as time went on in living oysters after inoculation.

17927. They considered that was due to the action of the oyster?—Yes, that would be due to the action of the tissues of the oyster upon the bacillus.

17928. Was there any evidence with regard to mussels or cockles?—I think not.

17929. Only the oyster?—So far as I remember.

17930. It seems to me that the American oyster relaid—without being relaid, in fact—ought to be fairly pure and safe?—Yes. Well, of course that raises the question of oysters imported from countries other than America.

17931. Well, not so much as from America; the sea journey is much longer. The question is, would not the healthy oyster from America have destroyed his bacillus typhosus before it arrived here?—Well, I think any measure which deals with that must be on the simplest and the broadest possible lines; I think there is a distinct danger that we should get more shell fish, both oysters and mussels, if this question is dealt with strictly at home, from foreign countries, probably other than America, say, from Holland. I understand that considerable quantities of mussels are imported from Russia, and I do not see how one is to deal with that except by some such provisions as that these shell fish should be relaid in pure sea-water, and that we should take ample securities; and besides that, I am assured by people who deal in these shell fish that they are much improved in quality by that procedure.

17932. The object of your recommending 14 days relaying in home waters—pure home waters—would be, to a large extent, obtained, would it not, by the importation of American oysters if they were properly kept on transport?—If they were properly——

17933. How are they imported—in what way?—They are imported, I believe, in barrels.

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17934. In barrels dry; or are they kept in water?—Oh, dry; dry, so much so, that I understand a certain number of them are found dead on the top of the barrels.

17935. I see, and that would not meet your difficulty about relaying in pure water?—In what way?

17936. That would not meet your difficulty about relaying?—I quite see the difficulty about the American oysters; I quite see that that is a big difficulty; but it seems to me that in dealing with this question here one would have to take precautions against an increased importation of oysters from abroad—or other countries in Europe—and that afterwards. if that should occur. you would be dealing with oysters over which you had no control whatever, and I do not see how you are going to distinguish between oysters imported from other countries and oysters imported from America. I think such a distinction would be very invidious. Of course I quite see there might be very great difference of opinion upon that subject, but that is how it strikes me.

17937. To what extent are American oysters relaid do you suppose in places like the estuary of the Liffey, and then imported into Manchester?—I do not know; I do not know the amount relaid in the estuary of the Liffey, but I believe very large quantities indeed are relaid in various layings. I have given a list, supplied to me by the markets' inspector, and I understand that large quantities of these American oysters are, as a matter of fact, laid at Cleethorpes, and others, I believe, are laid at Brightlingsea. Where all the relaid American oysters come from I am not in a position to say.

17938. You get them through Liverpool chiefly?—Yes, I am so informed.

17939. In the returns of cases of enteric fever, and your analysis of it, you use the words, "associated with and strictly due to"?—"Ascribable to," I think.

17940. "Strictly ascribable to"; would you just tell us what you precisely mean by those two terms; I did not quite catch your explanation?—Well, you see in mentioning those which might be ascribed to the consumption of shell fish, I have taken all the attacks which began within six days to a month of the consumption of raw shell fish, whether oysters or mussels, and where there was no other source of the disease ascertainable might be ascribed to the consumption of those shell fish.

17941. Of course you do not pin yourself to those figures?—No, I do not pin myself to them either positively or negatively. I think the chances are that the numbers were larger than those mentioned. I have rejected all those in which the shell fish were cooked, though cooking has been shown not to destroy the bacillus typhosus as sometimes carried out, amounting merely to scalding.

17942. Who conducts all those investigations?—The sanitary inspector; the facts to be ascertained, you see, are exceedingly simple.

17943. Yes. Well, what are the facts; how does the sanitary inspector go about it?—He has to ascertain—or we have to ascertain—in some way, the time when the disease commenced, and then he has to ascertain when the symptoms commenced; then he has to ascertain whether the patient had consumed shell fish at antecedent dates, and at what dates, and whether the shell fish which he consumed at those dates were raw or cooked. There is no great intellectual effort required for that purpose.

17944. Except the question of the symptoms, that might be a difficulty?—Yes, that might be a difficulty.

17945. To an unprofessional man?—Yes, that is so. We have a large number of cases associated with the consumption of shell fish, and that tells in both ways. Is cuts out as well as includes.

17946. I see that in the six years there were 2,644 cases of enteric fever. I have added up the numbers given each year, from 1897 to 1902; it comes to 2,644, and then the cases associated with the consumption of shell fish amount to 274; that is about 10 per cent., I suppose, roughly?—Yes, it would be.

17947. Do you consider that a large proportion or a small proportion?—Well, if you could ascribe them all to the consumption of shell fish, I should say it is a very large proportion; I do not do that.

17948. Because we have it in evidence here that as much as 50 per cent. in one town, and 36 per cent. in another town of cases of enteric fever were ascribed to shell fish?—Yes, that may be; but that may be if you take a seaside place or a place to which a large number of trippers resort. You may have a quantity of oysters derived from some one polluted laying presented to the visitors and to the inhabitants for consumption, whereas Manchester is supplied from a variety of sources, the great majority of which are probably quite, or tolerably pure. That makes a great distinction.

17949. Well are the great majority quite pure, do you think?—Well, yes; I should think a very large proportion of them are. I do not know whether you can say quite pure. In the first place, it has been mentioned that the American oysters have the certificate of the Government, and I think probably in the cold months that the majority of the oysters consumed in Manchester come direct through from America into the market without being relaid.

17950. You think they have come direct?—Through Liverpool, that is.

17951. The large majority?—Oh, yes, undoubtedly in the cold months; not in summer, in the cold months.

17952. And the time they chiefly consume American oysters is in the summer time, when the other oysters are out of season, in the spring and summer?—These oysters are consumed largely in the winter also.

17953. What is the proportion of oysters coming into your market as compared with mussels?—I should like to explain that American oysters are much cheaper than English oysters, and that American oysters are the food of the poorer classes.

17954. Quite so?—And I have not the slightest doubt that very large quantities are consumed in winter; in fact, I have mentioned in winter 500 to 1,000 barrels of American oysters are imported directly, each barrel containing 500 to 1,000 oysters. That shows the enormous quantity of American oysters which are imported direct, because the great bulk of them are imported direct.

17955. Have you got the amount imported from other layings, such as Irish layings?—No, I have not. I could not get that; it was very difficult to get exact information upon the subject, but the figures given above were furnished to us by a very large merchant.

17956. You get a good many of your oysters from Liverpool—your main supply?—Yes.

17957. Do you know that Liverpool firms fatten their American oysters in the estuary of the Liffey?—I have mentioned that as one of the sources. Mr. Holburn's report gives the complete list of sources; I presume Malahide, Dublin.

17958. That is not the estuary of the Liffey?—I am not aware.

17959. I see he says Dublin, which is, no doubt, a source of some of them?—Yes. Well, of course, this list covers only what he knows of.

17960. I see that the total amount of oysters sold in the market is 2,876 lbs. in the year, and that there are 136,802 lbs. of mussels sold. That is from the return which you have handed in with your evidence?—I am not aware that I have stated the number of pounds.

17961. Yes; between 1898 and 1902 you have given us a return?—Oh, condemned, not sold—condemned as unfit for human consumption. It certainly is an enormous quantity, and, of course, the fact that the bacillus of typhoid fever, even in very small amount, will grow on sick and dying shell fish becomes of considerable consequence in the face of these figures.

17962. Do you know the proportion consumed relatively of oysters and mussels?—No, I do not know, but I have given you the quantity imported, so far as I can ascertain it, namely, from 500 to 1,000 barrels of mussels, each averaging about 1 cwt., per week in the season.

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17963. Yes, I see that?—And also the quantity of oysters, and the quantities are very large. I may say that Manchester, I have stated, takes perhaps one-sixth, but it should be—takes about one-third of this amount. That was a misunderstanding of the information. Manchester takes about one-third of the quantity of oysters mentioned; it takes the whole of the mussels mentioned.

17964. What proportion of mussels do you suppose are eaten raw?—I could not tell you; it is impossible to say.

17965. Are they more largely consumed raw?—Oh, yes; large quantities are sold raw and eaten raw.

17966. And eaten raw?—And eaten raw; but I have no doubt that the larger quantity is cooked. But then the method of cooking has to be considered. They are simply plunged into boiling water, and taken out again immediately, and I believe it has been shown that that does not suffice to kill infectious germs. However, I have assumed that it would suffice so much to diminish the danger that I have not included those in the cases which have been put down as ascribable to shell fish.

17967. You say that the cases which may be strictly ascribable to mussels are in five years under 79 cases. That does not seem a large proportion, if mussels are eaten to a large extent raw, do you think?—Well, yes; one must remember that it is rather difficult. Yes, I consider that if we were correct—if all these cases could be ascribed to mussels—that that is a matter of serious import. Certainly, 79 cases of small-pox imported into a city would be a matter of very great moment.

17968. I am not saying it is of small moment. I am suggesting that it is comparatively small when compared with the amount of damage done by oysters?—Oh, it is small compared with the other sources of enteric fever; the figures show that.

17969. No; I am comparing it with oysters; that if the mussels are eaten in such very large quantities, and are eaten raw, it is a small proportion comparatively for mussels as compared with oysters?—Nevertheless, the cases which have been duplicated are in larger numbers, and those which we have been able with some definiteness to say are due to shell fish, have been found due to mussels. That, of course, is a fact which must be regarded as of considerable consequence.

17970. Do you know anything at all about the behaviour of bacillus coli or enteritidis in mussels or cockles?—No; I really do not put so much importance upon the bacteriological investigations. It has been perfectly definitely shown that where these layings are exposed to pollution, they are capable of producing considerable outbreaks, and that is sufficient with regard to fæcal contamination, I think. I do not think it is necessary to rely upon the bacteriological evidence for the purpose of showing that much, at all events, but it is necessary to protect the fisheries from fæcal contamination.

17971. What value do you ascribe to bacteriological evidence in this case?—In the finer issues it may be of some value; for instance, in that point where I have considered what is the relative risk of taking shell fish direct from our own polluted fisheries, or of consuming American oysters imported direct without relaying. These experiments on the behaviour of the bacillus of enteric fever in sea water in the presence of oysters, and when inoculated in the oysters, have a value in enabling one to form some idea of what was the relative risk from imported oysters, and from oysters taken from contaminated British layings; but in dealing with the larger questions of risk of contamination in any layings, I do not think that bacteriology is necessary.

17972. Mere topographical evidence is sufficient?—Yes; I think an ordinary clear intelligence is sufficient for the purpose.

17973. I see in your weekly tables, which you have presented to us for five or six years, that in May, June, July, and August, the four months in which the home-grown oysters are out of season, there are singularly few cases of enteric fever?—Yes.

17974. Has that anything to do with the oyster or shell fish question, do you think?—No, I should not say so. You see, I have pointed out that the autumnal increase of enteric fever in Manchester precedes the increase in cases attributable to shell fish; and I have said that contaminated shell fish are therefore not the cause. Now, it is quite likely that the same course of events is happening elsewhere—that the autumnal or other increase comes first, and the autumnal increase leads to the increased deposit of enteric matter in the shell fish in the layings, and that you consequently get the increased number of cases ascribable to shell fish. I should put it in that way.

17975. But, presuming mussels and cockles and foreign oysters are eaten during those three or four months?—Oh, no; the close season for mussels is from the 1st April to the 1st September, is it not?

17976. There is no close season in Ireland, for instance; they are sent over here all the year round, I take it?—Well, I imagine there is a great increase in the amount of mussels consumed in September.

17977. Take the foreign oyster during that period; there is a falling off in the number of cases of enteric fever?—Yes, that is so.

17978. Still you are singularly free from cases of enteric fever in those four months?—Oh, that is so.

17979. How do you explain that?—I do not profess to explain that. I may tell you that brings us back to the question where the shell fish consumed in Manchester come from, and I understand that the London and Manchester Oyster Company have very large layings in Loch Ryan, in Scotland. I do not wish to imply—I really do not know where the bulk of the oysters which are consumed in Manchester are derived from.

17980. Would not the foreign oysters be imported direct from America during those four months?—Oh, no; they are all taken during those months from layings where they have been put down in the spring.

17981. Is it not rather an extraordinary fact that during those four months of the year you are practically free from enteric, although the people must continue to eat shell fish, cockles and oysters—foreign oysters to some extent?—Yes, it is so, certainly.

17982. And you have, week after week, I see, for those particular months, no cases of disease connected with shell fish?—Yes, that is so, of course. It is certainly the more remarkable that one laying—namely, at Cleethorpes—is a laying which has been proved to have been contaminated, and there is no doubt that a considerable quantity of American oysters are laid down at Cleethorpes.

17983. Well, they do not give rise to disease in these particular months?—They do not appear to do so.

17984. With regard to your suggested measures, I suppose the best way to reassure the public is to protect the public against a recurrence of these scares?—It takes a little time, excuse me, to consider a question such as you put to me, and I should like to see if I have any information here as to the quantity of oysters brought into the market in summer. I think it is very probable, however, considering how rapidly they succumb to the hot weather, that the amount of oysters consumed is very much less in summer in the warm months. No doubt a large number of oysters are consumed at seaside places by trippers—American oysters, which are taken direct, even during the warm weather, from the layings; but that is in the middle and towards the end of August, and the period of immunity is then exhausted. I think that is probably the explanation why you get so few cases in summer.

17985. Still, to set against that I see that the person from whom you get the information here as to the quantities coming in, states that most of these mussels are condemned in the hot weather, so there must be a large amount coming in?—Oysters, no; the quantity of oysters is only 2,876 lbs.

17986. Mussels?—The quantity of mussels condemned is certainly very large, but then if you read further on he explains that is chiefly when the weather is warm in September and October, and the mussel season begins on the 1st September, so there is no inconsistency on that point. It may be added that enteric fever shows a subsidence at the commencement

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of the four months, which is sustained throughout. If this holds also at seaside places there is less infective matter going on to the bed during the four months.

17987. Well, we may pass from that. About the measures you suggest; you say that you desire to reassure the public. I suppose the best way to reassure the public would be to protect them against the continuance of this disease?—Oh, yes; it is the only way.

17988. With regard to the Rivers Board, do you mean the local sanitary authorities are to be passed over altogether in dealing with this matter?—Yes, I think so; it is a matter of fisheries, and I think that these might very reasonably be handed over.

17989. Is it not entirely a public health question?—Yes, it is a public health question.

17990. The question of dealing with these oysters; dealing with food coming in?—Yes.

17991. Would there not be a difficulty with regard to the medical officer of health, who is the servant, or the officer rather, of the local authority—the local sanitary authority?—Yes.

17992. And you desire, apparently, to put him into direct communication with the Local Government Board without any reference to the local authority which employs him; would not that be likely to cause difficulty?—But he makes his report—the proposal which I have made is that he shall state in his annual report, not that he shall communicate direct except in case of an outbreak.

17993. Yes?—But I do not wish to imply that he is not to report also to his sanitary authority.

17994. No, but you exclude the sanitary authority from having anything whatever to do with this question of shell fish by handing their functions over to the Rivers Board?—Yes; well, that is the suggestion made, and I think it is a very suitable one.

17995. Are not the estuaries really more in the hands of the local authorities than the rivers?—Yes, one would think the protection of the estuaries was the function of the local sanitary authorities.

17996. Who discharge their sewers into them?—Who discharge their sewers into them.

17997. I suppose you regard the sanitary authority as being rather involved themselves in the matter?—I think it is desirable to create an independent authority to deal with the question, certainly. But I see no reason why the subject should not be at present dealt with by the Local Government Board and Sanitary Authorities pending the constitution of Rivers Board.

17998. Oh, yes, you may have the independent central authority, just as you have got the Local Government Board at the present moment to deal with sanitary authorities?—You have companies who deal with these oyster layings, and you have the sanitary authorities who have certain rights for the admission of sewage into tidal waters, and although I think that in general all sanitary matters should be dealt with by local authorities, yet in consideration of the special circumstances, I think it is desirable to create an independent authority.

17999. And you think there would be no risk of friction between the sanitary authority and the medical officer of health in the matter?—Oh, I am quite willing to modify that statement to the effect that the sanitary authority shall report to the Local Government Board.

18000. That the report should go through the sanitary authority?—That the report should go through the sanitary authority. I have no wish to bring the medical officer of health into direct relation to the Local Government Board without his Authority; I did not intend that.

18001. You see there might be difficulties, I think, if you pass over the local authorities?—Yes, I did not intend that; that is a matter which I should regard merely as a formal question. I had no intention of suggesting that he should pass over his local authority.

18002. What do you mean precisely by "risk of contamination"? You speak of the "risk of contamination" in your measures that you would suggest. You speak of layings, fattening and storage beds, from which shell fish are taken direct to the market, and which, in the opinion of the Local Government Board, are exposed to the risk of contamination by faecal matter, should be disused. What do you mean precisely by "risk of contamination"?—Well, where it is quite clear that faecal matter must be carried into the layings—it must be carried into the layings owing to the introduction of such matter from the sewers, but there is much danger that this faecal matter shall find its way into the layings.

18003. Suppose you have a purification scheme, and you have got a large town or city discharging its sewage after purification into an estuary, what degree of purification would satisfy you—suppose there were oyster layings within the vicinity, say within a mile or two of the outfall works?—Well, no doubt that raises questions of some difficulty.

18004. But those are administrative difficulties that some people will have to contend with hereafter; we would like to have your opinion upon the question of risk of contamination?—Oh, I am aware that it is a matter which will have to be carefully weighed. In certain cases where the sewage is carried within a short distance of the layings, I should not admit any degree of purification as sufficient.

18005. Any degree of purification?—No, I should not.

18006. What do you mean by a short distance?—Well within 200 or 300 yards, or where sewage was carried a considerable distance in a narrow channel.

18007. You think that 200 or 300 yards of sea water in itself would purify?—I do not know of any degree of purification short of passing the sewage through a considerable quantity of land which would render it reasonably innocuous if taken within a short distance of an oyster laying. In other cases, of course, it might be sufficient if a very large amount of precipitation had occurred and the clear effluent were discharged at a greater distance from the layings.

18008. The number of pathogenic organisms would not affect it to any great extent, would it?—Oh, surely; there is no doubt that what danger exists exists partly because the infection is carried in clumps, so to speak; it is very unequally carried, and with proper treatment of the sewage the bacilli would be equally diffused in the effluent, and the danger would be much less when such an effluent was mixed with a large quantity of pure water. Besides that, with any proper precipitation scheme, the great bulk of the infectious germs would be thrown down.

18009. Then you think the risk would not be so very great?—I do not say so; I think it is all a matter of degree. Each case, I am quite clear, would have to be considered by itself. No doubt that is a question which raises important issues.

18010. Very important administrative issues?—Very important administrative issues.

18011. Very?—One would have to determine in what cases it would be hopeless to deal with sewage, and in other cases where the sewage was introduced at a very considerable distance from the layings, what degree of purification would suffice to remove the danger?—No doubt that would be a question for the Rivers Boards.

18012. With regard to compensation, who do you suggest should compensate these fishery owners?—Well, I presume that would be a matter for the Government.

18013. You think the Government ought to do so?—I see no other source from which they could be compensated.

18014. Would you tell me why they ought to be compensated at all?—Well, I have only said that the question of compensation might arise; if people have prescriptive rights which you suddenly deprive them of, the question of compensation always does arise.

18015. You do not compensate a fish merchant if you seize his fish which he brings impure to the market; you destroy it, and you prosecute him?—No, but if you have created—and I presume the Board of Trade has created—prescriptive rights in certain areas, and if it should be found impracticable for particular companies to find other layings, then in that case I should say the question of compensation might properly arise.

18016. But the butcher has got no prescriptive right to send tuberculous meat into the market and to sell it. Why should the fishery owners have prescriptive rights to send fish which is capable of communicating disease into the market?—Oh, I do not say; but you do not destroy the whole of a butcher's meat because one animal is shown to be tuberculous; you do not destroy the whole of the farmer's stock because one animal is shown to be tuberculous, but if you find a certain amount of danger arises in connection with a limited number of oysters from a laying, then the proposal is to entirely disuse the laying. I do not know that the circumstances are quite analogous.

18017. Suppose the oyster bed has been put down after the sewer has been constructed, do you not think that the oyster merchant or the owner of the fishery ought to try to protect himself? Why should he be compensated? Suppose he deliberately puts his laying in a polluted source, why should he be compensated?—I do not say that, I only say in certain instances the question of compensation might arise. I do not wish to dogmatise upon the subject. I am asked what would be the administrative difficulties, and I have mentioned that as one of the difficulties which might arise. As to the question in the particular instance which you mention, it is perfectly true that no company ought to have put down shell fish in such a situation, but it has to be considered, of course, that they did put them down before it was understood that enteric fever was liable to arise, and I presume that they put them down also with the sanction of the Board of Trade, so that it is in some degree a Government question. However, I do not wish to dogmatise upon that; I only mention it as one of the difficulties which is liable to arise, and which would have to be considered.

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18018. Just one question more with regard to foreign oysters; would a certificate of origin as to the purity of the source from which they came—would that satisfy you?—I believe a certificate of purity is given, is it not? But your question is with regard to all foreign oysters.

18019. Yes?—In each case?

18020. Yes?—Given by the Government of the respective countries?

18021. Yes?—Yes, well, of course, considering the whole of the practical difficulties which would arise, especially having regard to the American oysters, which I have really no doubt are comparatively free from disease, I think that might be enough. But there is this to be said, that when you have got such a certificate it might still be possible to import oysters under cover of the certificate from layings which were not free from contamination. I mean to say that the certificate given in respect of oysters taken from a pure source might be used to cover other shell fish. That is the only difficulty that I see in connection with that. I think, however, that, having regard to the practical difficulties of that question, perhaps such a certificate ought to satisfy one. The whole of the question is evidently an extremely difficult one. I have felt that in endeavouring to consider it, though I still think that all shell fish should be relaid in pure home waters before consumption.

18022. (*Colonel Harding.*) Have you formed any opinion of your own, or do you know of any investigation having been made to ascertain whether the consumption of mussels, apart from their contamination, is likely to give rise to disease; in other words, whether uncontaminated mussels are wholesome food?—I have no reason to suppose otherwise. Of course, no doubt mussels have on various occasions produced a special form of poisoning, but I have not the slightest reason to suppose that mussels from perfectly pure sea beds—from beds lying in perfectly pure sea water—are other than wholesome food.

18023. Your impression is that, apart from contamination, the consumption of mussels is a safe one?—Oh, yes, I think so, certainly.

Dr. J. C. THRESH, Medical Officer of Health, Essex, called in; and Examined.

Dr. J. C. Thresh.

18024. (*Chairman.*) You are Dr. Thresh, the Medical Officer of Health for Essex?—Yes.

18025. Are you of opinion that shell fish can be contaminated, and prove injurious to human beings; and will you give us your experiences on the question?—

During the past few years a considerable number of cases of enteric fever have occurred in Essex, attributed to the consumption of shell fish, chiefly oysters and cockles. At first the opinion that such shell fish could be the means of causing enteric fever was greatly doubted, the evidence in many cases not being absolutely conclusive. Now, however, the cumulative evidence of a series of outbreaks in this county and elsewhere has convinced the most sceptical that under certain conditions cockles and oysters may serve as the media whereby the infection of enteric fever is disseminated.

Such being the case, I have from time to time made reports to the Essex County Council upon investigations made at my own initiative, or at the request of local authorities or the owners of shell fish layings.

The majority of the cases of enteric fever in this county, which have been attributed to eating oysters, were infected by oysters purchased at Brightlingsea or taken from the Brightlingsea layings, but many cases of oyster infection were also attributed to shell fish purchased at Southend. Infection by cockles was almost entirely limited to cockles taken from Leigh Creek, though many cases occurred at Shoeburyness, attributed by me to cockles collected from the polluted foreshore opposite that town.

The above limitation is of great importance, as the above places are those where the shell fish layings were, or are, subject to gross pollution from sewage. The oyster layings in the Pyefleet, off Tollesbury, in the Crouch and Roach, which are not obviously liable to gross pollution, have never been implicated. I cannot call to mind any case of enteric fever which has been attributed to oysters taken from these layings.

From time to time, when outbreaks of enteric fever occurred, attributed to oysters or cockles, I have visited the implicated layings, taken samples, and submitted them to bacteriological examination. The results have not always been what I expected, that is to say, whilst I found the bacillus coli communis and the B. enteritidis sporogenes in nearly all cockles from layings which were obviously sewage polluted, I also found them in a smaller proportion of cases in oysters and cockles which I had reason to believe were not sewage polluted.

In connection with my investigation of the cockles at Leigh, I examined batches taken from about half-a-dozen different places at the mouth of the Thames, and in every batch I found the B. coli communis and the B. enteritidis sporogenes. Apparently all were polluted. At this stage I consulted Dr. Bulstrode, and he kindly obtained for me a bag of cockles taken from what he considered the safest ground around the English coast, sands near Grange in Morecambe Bay. These I examined on December 20th, and in them I found both the organisms giving the reactions I have considered characteristic of B. coli communis and B. enteritidis sporogenes.

My faith in bacteriological examinations was somewhat shaken. Either my tests were not conclusive proof of sewage contamination, or sewage was to be found everywhere, and it seemed probable, or at least possible, that organisms closely resembling those found in the human intestines might occur in shell fish without being derived from human excrement.

In a report published in the "Lancet" on December 6th, 1902, on an "Outbreak of Typhoid Fever and other illness due to Oysters," I give an account of a series

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of cases of typhoid fever and diarrhœa, undoubtedly due to the consumption of oysters from St. Osyth Creek. In these oysters I did not find the B. coli communis but a bacillus, which I believe is the B. enteritidis sporogenes, was found in nearly all, and at a later date, when I examined the water from this creek, I found the B. coli communis in 1 c.c. and the B. enteritidis sporogenes in 250 c.c.

Although the creek water was bacteriologically unsatisfactory, the fact remained that of the enormous number of Portuguese oysters taken from this creek only a few sold in a certain place, to wit, Mistley, had been suspected of causing illness. Moreover, the extent of the pollution in this creek must be very small, and it is impossible to conceive that a localised portion of the creek could have become specifically contaminated. If such slight contamination as occurs here can infect a few only out of a series of layings, then it would appear as if no layings in the county could be considered absolutely safe. I am driven to the conclusion that the oysters which caused the typhoid fever became infected after being taken from St. Osyth Creek, probably by the very polluted water found in the River Stour at Mistley. (The crude sewage of Manningtree and Mistley runs into the river not far from where the boat from which the oysters were sold. was moored at Mistley).

I have referred to the above examinations to indicate the extent and nature of my experience prior to the commencement of this year, when the "oyster scare" again directed my attention to the layings on the Essex coast.

I should also state that I had been impressed by the fact that in the accounts of outbreaks occurring outside Essex, the shell fish implicated had, I believe, in every instance been taken from layings which on inspection were found to be obviously polluted with sewage.

My recent investigations, therefore, have been based upon conclusions at which I had arrived from previous experience, and from a consideration of the facts published in connection with outbreaks which had occurred outside the county.

These conclusions are that the safety or otherwise of any given laying can only be decided after taking into consideration a number of factors, and that these factors vary in importance. I arrange these as under in the order of their importance, in my opinion:—

(1) An examination of the surroundings of the laying to ascertain exactly the possible sources of pollution, their quality and extent.

(2) The bacteriological examination of the water taken from over the layings, preferably at low tide.

(3) The bacteriological examination of the oysters from the laying

(4) The chemical analysis of the water referred to in (2).

As my mode of procedure has not been quite uniform I will now give briefly an account of the examinations I have made during the present year, and the conclusions at which I have arrived as the result thereof.

Brightlingsea Layings.—These I have inspected many times. The sewage at Brightlingsea is now treated by chemicals coarsely filtered through matting, then allowed to accumulate in a settling tank, and the effluent drawn off and discharged into the Colne estuary at a point decided upon by Dr. Bulstrode and myself as a result of float experiments. The discharge takes place on the ebb, and is completed two hours before the turn of the tide. The estuary is about half-a-mile wide here at low water. (*Vide* map). The layings nearest the sewer outfall have been abandoned. The pollution of the Colne otherwise remains as described in Dr. Bulstrode's report to the Local Government Board. Compared with the enormous volume of water which enters the estuary twice a day, the pollution by sewage must be almost infinitesimal, yet in my opinion it is such as to admit of detection bacteriologically. The conditions in Brightlingsea and St. Osyth channels are practically identical, they form part of one and the same creek. The creek from St. Osyth receives slop-water from three or four cottages, and as far as I can ascertain this is all the sewage which enters the Brightlingsea creek directly.

On February 5th the Clerk to the Brightlingsea Urban District Council obtained for me two samples of water, one from over the Brightlingsea layings and the other from over the St. Osyth layings. These he certified had been taken by himself and sent off to me by the next train.

They were examined bacteriologically only, and the results given on the Table attached.

The results not being entirely satisfactory, I communicated with the Clerk, Mr. Osborn, and upon receipt of his reply, stating that he had received a report from Dr. Klein on a batch of 25 oysters from the creek stating that they were "not polluted," I concluded that I had better let the matter rest for the present, especially as I had undertaken to investigate the Pyefleet layings, which are in the same estuary, for the Colne Fishery Board.

On March 19th I inspected the Pyefleet, using the steamers belonging to the Board. I commenced with tide at its lowest, and remained there for about five hours. I anticipated that the pollution (if any) would be most obvious soon after the tide commenced to flow. The low tide also enabled me to examine the mud banks on both sides of the Colne, from its mouth to the Pyefleet entrance. Samples of water were taken, many dredgings were made, and each dredging was examined to ascertain if there was any discoloured mud brought up, and samples of some of the weeds and debris were collected in proper bottles. From special dredgings made at points indicated by myself I took samples of oysters. I ate a few from each batch. I visited Pewit Island and examined the oyster pits, made enquiries about barges entering the Pyefleet, etc., and assured myself, as I had done on more than one occasion before, that no polluting matter derived from drains, farms, or other similar sources, enters the Pyefleet unless it be with the tidal water from the Colne.

Four samples of water were collected, three batches of oysters, two samples of dredgings, and one sample of mud from the bottom of an oyster pit on Pewit Island.

To complete the examination I got the manager of the Board to collect for me three other samples of water at the height of the incoming tide, one from off Sandy Point, another from Mersea flats, and the third from the open sea beyond Colne Point.

All these samples have been examined, and the results are given in the appended Table.

Basing my conclusions upon the evidence of experience, and the various examinations just recorded, I reported "in my opinion the Pyefleet layings are quite satisfactory, and that oysters therefrom can be consumed without the slightest risk."

Tollesbury Layings.—Since Dr. Bulstrode's report a small bacterial installation has been constructed at Tollesbury for treating the sewage, and the effluent is discharged on to the salting bounding the Woodrup Creek. The village is provided with pail closets There are only one or two water-closets in the whole place. The sewage effluent is lost on the saltings, and its presence cannot be detected by inspection more than one or two yards from the outlet. The nearest layings belong to private owners. and are over one mile away in the North and South Channels. They are surrounded by saltings and marshes, and I can find no possible sources of pollution.

Mr. Banyard, the Rural District Councillor for Tollesbury, himself obtained and delivered to me two samples of water taken from the North and South Channels respectively, and also about 50 oysters taken from the beds there.

The water, in the amounts examined, gave no indications of the presence of either the B. coli communis or the B. enteritidis sporogenes. A chemical analysis was not made. Neither of the above organisms was found in the oysters examined. *Vide* Table.

In this case I reported that the layings were perfectly satisfactory. Later, Mr. Banyard sent me another batch of oysters from the Upper and Lower Grounds of A. E. Chatterton and Co. These were

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examined, and the Table shows that the B. coli communis was not found in a single instance, and the B. enteritidis sporogenes only once. I expressed the opinion that these oysters were quite satisfactory.

Still later, Mr. Banyard obtained for me three samples of oysters from the laying of the Tollesbury and Mersea Fishery Company, one from the south shore, another from the Deep, and the third from Thursfleet. I did not visit any of these layings. A large map was sent me showing the position of the layings and the points from which the oysters had been dredged. I know the locality well, having cruised a good deal in the neighbourhood, and the nearest possible source of pollution is a little slop water which enters the Strood Channel from a drain near the Victory Inn on Mersea Island. This enters a different channel, and the two channels only communicate about a mile below I did not think it necessary to have any sample of the water. It must be the same as in the adjoining channels.

Here again, out of a series of 12 experiments, the B. coli communis was not detected in a single instance, and the B. enteritidis sporogenes only once.

I regard these results as eminently satisfactory, and reported this to the company.

About the layings at Tollesbury I certainly think there can be no question as to their satisfactory character. If they are not safe, there cannot be any safe layings round the coast.

The Crouch Layings.—The Burnham layings were examined at the request of the Burnham Urban District Council. I visited the town on January 7th, and first made a careful examination of the sewage works. Since Dr. Bulstrode's report a very complete system of sewage treatment has been installed, consisting of primary and secondary coke bacteria beds and a large storm filter. I have watched these works from their completion. The effluent is always fairly clear, and of good quality chemically. It averages 30,000 gallons per diem in dry weather. Nearly all the cottages and houses have water-closets. There is no storm overflow, so that all the sewage is treated before being discharged. The effluent is discharged into a marsh ditch, and some half mile below after becoming further diluted with the water from another ditch it is discharged on the outgoing tide into the river. I examined the river at low tide, and found no signs of deposit on the mud near the outfall. I then rowed out over the layings and took samples of river water there. The analyses of the river waters are given in the tables. The fattening beds are fully 3½ miles further down the river. The only possible sources of pollution are from the above effluent outfall and from the Rochford outfall into the Roach, which enters the Crouch between the town of Burnham and the fattening beds. The river here is ¾ to 1 mile in width, so that the effluents entering at points miles away must be diluted a million of times. Samples of oysters were collected for me from the fattening beds and two samples of water. These waters were examined bacteriologically, and no sewage pollution was detected in the quantities examined. The oysters were also examined, and out of six no reaction for the B. coli communis was obtained, but in two instances the reaction for B. enteritidis sporogenes was given.

Taking everything into consideration, I reported that, in my opinion, these layings were perfectly satisfactory.

The only other layings examined are those in the River Roach and its offshoot, the Potten Creek, and the results are interesting, since they revealed a possible source of danger hitherto unsuspected. The only source of pollution with which I was acquainted was the sewage effluent from Rochford. I examined the river between Rochford and the lock at Stanbridge Mill. It was in a most filthy condition. I had the sluice gate opened, the tide being low, and after a time the water which passed through was black and offensive in the extreme. This lock, however, is about six miles above the fattening beds, and even this foul effluent becomes lost to vision a little distance below, where the river becomes much wider. The layings between the mill and Potten Creek must be liable to occasional pollution. The filthy sediment which comes down when the gates are open may settle on the beds. Mr. Wiseman, one of the principal oyster merchants on the Roach, and who accompanied me, at a later date, wished me to examine some of the oysters, as he believed that I should find that they were not affected by the sewage. He accordingly collected for me a batch from the "Cock's" laying which are on the north bank of the Roach, opposite Potten Creek, and a batch from the Potten layings near Wakering Ferry. Samples of water taken at low tide over both layings were also collected.

The analysis will be found duly recorded in the table. The results, in my opinion, show that, at the time, the water and oysters from Cock's layings were not affected by sewage, but that the water and oysters from Potten Creek appeared to be so affected.

This was exactly opposite to what I had anticipated, but further inquiry led to the discovery that a large number of barges discharge at a wharf in Potten Creeek, at a point half a mile above the layings. These barges bring house refuse from London for the use of the Wakering brickmakers. After unloading they pump out the offensive and highly polluted bilge water into the creek. As there is quite a fleet of vessels engaged in this traffic, and as many as six (?) may be discharged in a day, the pollution of the creek may be serious.

I reported that the oysters from the "Cock's" laying showed no signs of contaminaton, but that I did not regard it safe to take oysters direct from there for sale, and that the Potten layings were contaminated with sewage or manurial matter.

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CHEMICAL Analyses of Waters taken in connection with the Examination of Oyster Layings.

Source, &c.	Results expressed in parts per 100,000				
	Chlorine.	Nitric Nitrogen.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed.
Colne Estuary:					
Off Sandy Point - - - - - - - -	1930	·06	·001	·010	·107
Off Mersea Flats - - - - - - -	1960	·000	·004	·008	·050
Just outside estuary - - - - - - -	2100	·000	·001	·007	·059
Entrance to Pyfleet, ½-hour after flood - - - -	1950	·06	·007	·010	·064
,, 2/3rd flood - - - - - - - -	2050	·04	·002	·008	·049
In Pyfleet. East end of Pewit Island - - -	1994	·04	·008	·009	·064
,, West of Island - - - - - -	1994	·036	·006	·008	·063
River Crouch:					
Burnham effluent entering river - - - - -	—	t	·44	·036	·49
River about 100 yards below - - - - - -	2000	t	·008	·010	·062
River Roach:					
Below Rochford Sewage Works - - - - - -	437	·00	2·29	·30	1·9
Over Cock's Layings - - - - - - - -	1900	·08	·003	·010	·064
,, Potten layings - - - - - - -	1874	·06	·006	·008	·064

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OYSTER LAYINGS—ESSEX.

BACTERIOLOGICAL Examination of Water taken from over or near Layings.—*J. C. Thresh.*

—	Number of Organisms per c.c.	Phenol Broth. Qty.	McConkey's Solution. Qty.	Anaerobic Milk. B.E.S.	Milk.	Glucose Gelatine.	Litmus Lactose.	Indol.	—
Brightlingsea Creek Water -	3,000	+ 1 c.c.	− 1 c.c.	− (250 c.c.)	+	+		+	
St. Osyth Creek Water - -	4,509	+ ,,	− ,,	+ ,,	+	+		+	
Colne Channel, opposite Pyefleet.	5,000	+ ,,	+ ,,	? ,,	+	+		+	
In Pyefleet. Entrance. Low Water.	1,980	+ 5 c.c.	? 2 c.c	− ,,	−	+	?	−	
In Pyefleet. Entrance. Towards High Water.	2,820	+ ,,	? ,,	+ ,,	+	+	?	+	
In Pyefleet, opposite Island -	2,060	+ ,,	? ,,	+ ,,	+	+	?	+	
,, West End - -	1,900	+ ,,	? ,,	+ ,,	+	+	?	+	
Colne Mouth, Sandy Point -	266	− 5 c.c.		− ,,					
,, Mersea Flats -	45	− ,,		− ,,					
,, Colne Point -	130	+ 1 c.c.	− *	+ ,,	+	−	−		* Sol. inoculated from growth in phenol broth.
Tollesbury, North Channel -	10,000	− ,,	− 1 c.c.	− ,,					
,, South Channel -	8,500	− ,,	− ,,	− ,,					
Crouch, Hozier Layings - -	1,360	+ ,,	− ,,	− ,,	+	−		−	
,, Holywell Layings -	1,210	+ ,,	− ,,	? ,,	+	−		+	
Roach, Potten Laying - -	550	+ ,,	+ *	− ,,	−	+	+	+	* Ditto.
,, Cock's Laying - -	450	+ ,,	? *	− ,,	−	−	?	−	* Ditto.

Where a motile bacillus was found in the phenol broth, this broth was used for inoculating milk, glucose gelatine, litmus lactose solution and plain broth, and the results are recorded in the last four columns.

Oysters from—	Phenol Broth.	McConkey's Solution.	Anærobic in Milk, B.E.S.	Glucose Gelatine.	Litmus Lactose.	Milk.	Indol.
Colchester - - - - - - -	+	–	–				
Upper part of Pyfleet - - -	–	–	–				
	–	–	–				
	–	–	+				
	–	–	+				
Off Island - - - - - -	?	?	–	–			
	–	–	–				
	?	–	–	–			
	+	?	–	+	+	+	+
	?	–	–				
East End - - - - - -	–	–	–				
	–	–					
	+	?	–	+	–	+	–
	–	–	–				
	+	–	–	–			–
	+	–	–	–			–
	+	–	–	+			+
	+	!	–	–			+
	+	–	–	–			
	+	+	–	+	+	+	+
River Roach, Cock's Layings - -	+	–	+	–			–
	+	–	–	–			–
	+	–		–			–
	+	–	–	–			–
	–	–	–				
	–	–					
	–	–	–				
	–	–	–				
	–	+					
Potten Layings in Creek - - -	–	–					
	+	–		–			+
	+	+	–	+	+	+	+
	+	?	–				+
	+	–		–			+
	–	–	–				+
	+	+		+	–	–	+
	+	–	–	+		–	
	+	+	+	+	+	+	+
Crouch, below Burnham :							
Holywell Layings - - -	–		–				
Ditto - - -	+		+	–	–	–	–
Ditto - - -	–		–				
Hozier Layings - - - -	–		+				
Ditto - - - -	+		–	–	–	–	–
Ditto - - -	–		+				
Tollesbury, Private Layings - -	–	–	–		–		
Ditto -	–	–	–		+		
Ditto - -	–	–	–		–		
Ditto - -	–	–	–		–		
Upper Ground, North Fleet - -	–	–	–		–		
	–	–	–		–		
	–	–	–		–		
	–	–	–		–		
	–	–	–		–		
	–	–	–		–		
Lower Ground, North Fleet - -	–	–	–		–		
	–	–	–		–		
	–	–	–		–		
	–	–	–		+		
	–	–	–		–		
	+	–	+	–	?	+	–
South Fleet - - - -	–	–	–		–		
	–	–	+		–		
	–	–	–		–		
	–	–	–		–		
The Deep - - - - -	–	–	–		–		
	–	–	–		–		
	–	–	–		–		
	+	–	–	–	–	+	
Thursfleet - - - - -	–	–	–		?		
	–	–	–		–		
	–	–	–		–		
	–	–	–		–		

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I have since inspected the River Roach and Potten Creek, and visited the Wakering brickfields. There were two vessels in the creek from which London house refuse was being discharged. Although much care was obviously being taken to prevent the filth getting into the creek, the tide being low, I could see a certain amount embedded in the mud around. This was half a mile above the layings. The manager of the brickfields assured me that no bilge water was ever pumped into the creek, but a man with me asserted that he had seen this done. I could not find any drainage from a house or farm entering the creek. Thames water enters every tide, and may bring up a little polluting matter, and I am inclined to think, from the inspection, that there is nothing here which could so affect the oysters as to render them unsafe for use as human food.

London manure is largely brought by barges into Essex, and sometimes unloaded not far from oyster layings.

18026. Then I ask you whether you consider the rules in regard to shell fish can be amended, and if so, in what respect?—I certainly think there should be some amendment. It is very difficult to say how that can be carried into effect. The chief thing, in my opinion, is the position of the layings from which the shell fish are taken.

18027. Do you consider that these layings ought to be registered?—Yes, I think every laying should be registered.

18028. And that there should be some authority which should be charged with the inspection?—Quite so.

18029. Well, now, have you at all considered what that authority should be?—Well, I consider it should either be the Local Government Board or the County Councils; I am inclined to think the Local Government Board.

18030. You would be in favour of a central authority?—A central authority would not be amenable to local influences, like the local authorities are.

18031. (*Sir Michael Foster.*) That is your objection to the local authorities, that they are amenable to undesirable local influences?—I am sorry to say that is the case.

18032. (*Chairman.*) I do not know whether you have seen any of the reports of this Commission?—Yes, I think I have seem them all.

18033. Well, would you be disposed to think that if such a central authority as we propose and the Rivers Boards, which should have the control of the country, were established, these authorities would be suitable for undertaking the control of the layings?—The River Boards?

18034. Well, we propose to divide the country into districts?—Yes.

18035. With a River Board to look after each district and generally to protect it?—It is only a question of making the Boards sufficiently large or representative, so that too much influence from any particular locality cannot be brought to bear upon them.

18036. Might I take it that you would consider these Rivers Boards, with a central authority or the Local Government Board at their back, as suitable authorities for looking after the layings of shell fish?—Yes, I should think they ought to be quite suitable.

18037. (*Sir Michael Foster.*) I rather gather, Dr. Thresh, from statements you have laid before us, that in the earlier researches you laid too much stress, and you put too much confidence in the mere bacteriological results?—Well, I have come to that conclusion.

18038. You took, I suppose, as the characters of bacillus coli communis and bacillus enteritidis sporogenes, those characters which were accepted by the bacteriologists?—Yes, at the time, I think. I based my conclusions on the results of actual experience in connection with potable waters, and my experience was to this effect, that potable waters which gave no indication of the presence of the bacillus coli or the bacillus enteritidis sporogenes in reasonable quantities, were perfectly satisfactory, and where I found either of those organisms, almost invariably further investigations showed that the waters were liable to pollution. I have made so many examinations of that kind that I have got a considerable amount of confidence in it. When I came to examine cockles, I found that I got these organisms in almost all the samples.

18039. Did you make any distinction as to the number of organisms that you found?—In the water?

18040. For instance, in the oysters; on the second page you are contrasting two sources; for instance, those obtained from sands near Grange, in Morecambe Bay, you found both the organisms giving the reactions. Did you find them in the the same number that you did in the results you spoke of in another laying higher up?—No, not quite. I think it is stated somewhere in this report that there was little difference in the cockles that came from the mouth of the Thames. I believe I found them in practically every cockle, and I found them in a considerable proportion of those from Grange.

18041. And you were not examining the water in which they were lying, were you—that was only the cockles?—No, that was only the cockles.

18042. You take now the accepted characters of bacillus coli, do you?—Yes, if I were examining a water for bacillus coli, or a cockle, or an oyster, first of all, we inoculate phenol broth. If a cockle or oyster, ·1 to ·5 c.c. of liquid in shell is added to 10 c.c. If it is a water, we take 1, 5, and 10 c.c., mix it with broth to bring it to the requisite strength containing ·05 per cent. phenol. That is incubated for 34 hours. If the liquid is uniformly turbid a drop is taken out to see whether it is a motile baccilus, then from that we make plates, McConkey's solution, litmus lactose, and so on.

18043. We need not go into the details in your statements here with regard to glucose, and so on; those are applied, I suppose, to a culture?—Yes.

18044. Your bacteriological examination of oyster layings; you are giving the results there?—Yes.

18045. You give, you see, glucose litmus and indol?—Those have been taken in almost all cases from phenol broth. There may have been one or two cases in which it was taken from McConkey's solution.

18046. Then I gather, do I not, that in addition to a bacteriological result you think it is desirable to have topographical results. For instance, you say here you put them in order of importance, first an examination of the surroundings of the layings?—Oh, I think that is of vital importance, because you may have the opportunity of an occasional pollution. For instance, in the River Roach the whole of the sewage of Rochford is said to be treated, but after treatment it is, if anything, worse than before, and it goes direct into the river. About half a mile or three quarters lower down are the mill gates, and the sewage accumulates there, and there is a thickness of mud deposited on the bottom. At the sweet will of the mill owner the gates are opened; the whole of this goes rushing down the Roach. I had the gates opened when I was down there, and the amount of filth that went down could not be believed unless it was seen—and all that has to go over the oyster layings. The mill gates are perhaps not open for a couple of months. You examine the layings, the water over them, and the oysters themselves, and may find them perfectly satisfactory, and yet this pollution might occur every now and again.

18047. After it occurred I suppose you would find the evidence on the layings themselves?—Well, that I do not know. Unfortunately, I did not get any oysters at that time. It would have been rather interesting to know whether that was the case or not. But there is much turbid matter—a certain amount of it, I think, must be deposited there.

18048. But in any case, instead of trusting to the mere bacteriological result, you think you should have the topographical result confirmed, as it were, by the bacteriological?—Certainly.

18049. Very often if the bacteriological evidence is not sufficient and the topographical evidence is very strong, that will satisfy you?—I think so.

18050. You say, "A bacteriological examination of the water taken from over the layings, preferably at low tide." That would depend, would it not, upon the exact position of the outfall, for instance, in relation to the layings? If there was a laying at some distance it might be brought up at high tide?—I was thinking more of the conditions that obtain in my own county. I certainly have found that the waters at low tide are always more turbid than the waters at high tide. I have made some examinations of the Thames water at Leigh, at various states of the tide, coming down and coming up, and when the tide is high. When the tide is

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high the water appears to me quite satisfactory, but when it is getting low, going out, you can undoubtedly detect sewage both chemically and bacteriologically, and the same applies to the Colne.

18051. One can conceive circumstances in which the sewage would be brought to the laying at high tide?—Yes, I think it would depend on the position of the laying relative to the source of the sewage.

18052. Then I see you state very strongly: "In my opinion the Pyefleet layings are quite satisfactory, and that oysters therefrom can be consumed without the slightest risk"?—Well, there we come to a question of experience. We know that these oysters are used in enormous numbers (for example, at the large oyster feasts), and there has never been the slightest suspicion of a Pyfleet oyster causing illness; certainly I have never heard of a case.

18053. So that your result there is based upon experience, and not upon examination?—The examination bacteriologically was not as satisfactory as I should have liked. The condition of the Colne is not what I should like it to be.* If I had anything to do with the Board I should insist upon certain improvements being carried out quite quickly.

18054. Then there is something somewhat similar at Mersea; there the results are topographically very satisfactory, are they not?—Yes.

18055. At the same time there is that discharge close to the Victory Inn; I mean one sees the drains running?—Quite so; but there is a very considerable distance between the drain and the oyster layings, and the enormous amount of dilution that the small amount of sewage gets I think must render it harmless.

18056. You think it is absolutely impossible, for instance, for the baccillus typhosus—supposing, we will say, there was a case at the Victory Inn, supposing there was a case, for instance, a person came down there convalescent from typhoid fever, with the urine loaded, as it may be, with the bacillus typhosis and discharging into that drain there, do you think there would be no danger whatever to the layings somewhat lower down?—Yes, but the layings lower down are the local Mersea laying, not the ones to which I am referring. I am not certain that there is not some danger to some of these layings at Mersea; but those belong to small private owners, and it is some years since I saw them. I visited them with Dr. Cook, and my impression is that the Victory drains were a danger to some of these private layings.

18057. I thought this referred to Tollesbury, which is close by?—It is a little way off; a mile westward.

18058. In the tables you give here I do not quite know what your quantities are here in the second table, plus and minus; that is present and absent?—Quite so, plus signifies a positive reaction and minus a negative reaction.

18059. And that means bacillus coli?—Yes.

18060. Simply present in the specimen, is it?—Yes; do you refer to the oysters or to the waters?

18061. I am referring to the second. Are these the waters—I mean the second, this one (showing)?—In the one which runs longitudinally, the first one, Brightlingsea water, you get phenol broth 1 c.c.; it is present in 1 c.c.?—Yes, the reaction is given by 1 c.c.

18062. Then you come to the next page, "Upper Pyefleet"?—Yes.

18063. I see "plus" means "present," which I suppose means that the bacillus coli is present?—Yes, in 1 c.c. (I think there are two dots there indicating ditto) the reaction was positive.

18064. Not in my copy; it is simply "plus" and "minus"?—But on the previous page phenol broth, quantity 1 c.c.

18065. That was not quite clear?—I may say all besides phenol broth will be secondary; I ought to have marked them "primary" and "secondary."

18066. For enteritidis do you try the effect upon animals?—No, I do not. I ought to say in connection with enteritidis, unless I get the characteristic coagulum described by Klein, the indication of a pink tint at the surface and copious evolution of gas which is inflammable, I should not regard it as bacillus enteritidis sporogenes, but if I get these I should put it down to the bacillus enteritidis sporogenes. I have no opportunities for experiments on animals.

18067. No; otherwise that is a desirable test, is it not?—Yes, I dare say it is, but my experience in connection with waters is that if you find there has been previous sewage pollution——

18068. (*Sir William Ramsay.*) Do you think that the ordinary methods of purification of sewage would so far deprive them of bacteria as to make them innocuous?—I do not.

18069. Then what is to be done; would you recommend absolute stoppage of the effluent into waters which are inhabited by shell fish?—We are all looking forward to the report of this Commission as to what should be done.

18070. That is, would you yourself be in favour of sterilising the effluent?—If you could devise some process by which it could be done at a reasonable cost.

18071. But you regard it as dangerous that ordinary effluents should run into waters inhabited by shell fish?—My experience of these effluents, so far as bacteria is concerned, is that they practically contain as many as the raw sewage, and they are practically of the same character. I examined some the other day from works with secondary filter beds, the raw sewage, and a sample which had gone through a small septic tank, then through a primary bed, and then through a secondary bed. A certain amount of nitrification had taken place, and chemically it was a satisfactory effluent. I made dilutions with the sewage and with the effluent and tested them as described by Dr. Houston, and I carried the dilutions down to a million, and I got the same results in both.

18072. (*Chairman.*) I did not quite catch what you said it had been through?—It had been through a small septic tank. The septic people would say it was not a septic tank; it was not large enough; call it a detritus chamber if you like, then through primary filter beds and secondary filter beds. It gave a perfectly odourless, almost colourless, bright, well ærated effluent, and yet that evidently contained at least one million microbes per c.c.

18073. (*Sir William Ramsay.*) Do you know the sewage purification process at Brightlingsea?—Yes.

18074. You do not regard that as at least satisfactory?—It is not; it is no bacterial purification at all; it keeps out the solid matter, that is about all that it does.

18075. (*Major-General Carey.*) Does treatment by land make any difference in the number of bacteria?—Yes, it does, but it is some time since I made any experiments. I must say I was rather surprised that there was such a large number left in, but not nearly so many as when passed through grosser material. I think it must follow that in filtering through land a certain proportion is kept back; still, the effluent from land always swarms with organisms.

18076. (*Sir William Ramsay.*) Do you know any case where local inflammation has been produced owing to the fishermen cutting their hands with their knives when handling mussels? I heard of a case the other day in which there was a very severe case of infection of the hand, evidently from septic poisoning, and it was a question of the hand being removed?—I never heard of one, and, of course, not hearing of one, I have not made any inquiries.

18077. (*Chairman.*) Did you say that there was a large number of bacteria in the effluent after the land treatment?—Yes. I am afraid I have not any figures here. It is a long time since I made the experiments. I did some experiments in connection with the Romford and the Bishops Stortford sewage farms.

18078. But do you happen to know whether the land treatment was what you would call satisfactory land treatment?—Well, the Romford farm, I think, is one of the best managed sewage farms in England.

18079. Well, then, of course, if you have to compare land treatment with artificial treatment, you would have to compare the very best land treatment with the very

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* Since this date the new sewage purification works at Colchester have been completed. All the sewage is now treated on bacteria beds, after subsidence.

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best artificial treatment?—Quite so. Of course, wherever possible, I am in favour of land treatment.

18080. (*Mr. Stafford.*) In your statement what evidence do you refer to as having convinced the most sceptical as regards mussels and cockles causing enteric fever?—I regard what has generally been published during the last five or six years——

18081. You say with regard to your own county—the county of which you are Medical Officer of Health?—In my own county I have had many of these cases; I have not got a list of districts with me, but during the last six or seven years there has not been a year in which I have not had several.

18082. Would you tell us about any particular out break?—I gave details at my last examination with reference to an outbreak at Shoeburyness. I do not know whether I referred to one at a place called Heybridge Basin, which certainly convinced me that cockles could convey the infection of typhoid fever. They had an outbreak of typhoid fever at Heybridge Basin, and I found that the one thing common to all the patients was that they had eaten cockles; that they had bought them from a certain man who had picked them from the mud below, that mud being sewage polluted.

18083. (*Sir Michael Foster.*) Was that the only thing that was common?—The only thing that appeared likely to cause typhoid; but three cases occurred in one house in Heybridge Village, which is a mile and a half away. Upon inquiry there I found that between 14 and 20 days before some cockles had been purchased at Heybridge Basin, and taken to this house and presented to the family, that they had cooked them and eaten them, and out of the four people who ate them three had typhoid fever.

18084. (*Mr. Stafford.*) Have there been any extensive outbreaks, then, in Essex, in connection with cockles or oysters?—No. Then I refer here to a recent one where we had cases at Mistley—some of the patients came from Chelmsford—where they all obtained their oysters from a man who sold them at Manningtree; these oysters coming from Brightlingsea. All the cases were infected at Manningtree, and it was rather a considerable outbreak.

18085. (*Sir Michael Foster.*) Where is Mistley?—Mistley is on the Stour.

18086. There are no layings?—There are no layings.

18087. (*Mr. Stafford.*) You say pollution of the creek there is very little?—At Mistley?

18088. Yes?—At one point it is very marked. The whole sewage of Mistley and Manningtree goes out into the river and very near the quay, and the mud in the summer time is most offensive. For years we have been at the authority to try and get something done. They did get out a scheme which the Local Government Board would not sanction.

18089. I presume that no mussels disseminate enteric fever?—Well, we have made inquiries about that, but I have not heard of a case which I could attribute to mussels.

18090. Are they largely used in the towns?—I do not think to anything like the extent of cockles. I think not. In Southend you see them; they are exposed on plates; in our rural district of Essex I very rarely see them, whereas I see cockles frequently.

18091. You have never examined the mussels?—No.

18092. You have examined cockles for coli?—Oh, yes, a large number.

18093. And do you find cockles always have coli bacillus?—In reference to that the Leigh District Council and a committee of Southend fishmongers have obtained for me cockles from all round the Essex coast, starting from about Bradwell right round to Leigh, and I found them in all.

18094. How do you account for that?—I think it must be Thames sewage; I do not see what else it could be; the London sewage.

18095. (*Sir Michael Foster.*) Did you find them in abundance?—Yes, I should say in two out of three, if not in all of them.

18096. In two out of three cockles you got a growth?—Yes, it gave the usual indications of coli. I do not know when those were done quite—yes, in August of last year. Then I tried a number of experiments in connection with boiling and rinsing them with vinegar. I found that rinsing with vinegar appeared to sterilise the outside, but when the cockles were cut in two you could still find the bacillus coli.

18097. (*Mr. Stafford.*) Have you examined the mud or sand in which these cockles are found at all?—Only the mud about Leigh.

18098. Did you always find coli in the mud?—No, I did not.

18099. Although you found it in the cockles?—Yes.

18100. How do you account for that?—I do not know whether the cockles have some faculty of taking up—of conserving these particular organisms.

18101. You do not suggest that coli is a normal constituent of the cockle?—Well, I began to think at one time that it was.

18102. Have you had any reason to alter your opinion now?—I think that if we bind ourselves to the most recent definition of coli we should find that it is not a true coli in some instances which I have regarded as the coli.

18103. There are some coliform organisms?—For instance, I may say that until the last six or seven weeks I did not always apply the test litmus lactose broth. Since I have applied that I find in regard to the number of instances which I should have put down as bacillus coli I have not got the fermentation of that broth, and now I say it is a coli-like organism very likely a proteus, but not a true coli.

18104. But when you speak of the coli being present in nearly all samples of oysters, do you mean the bacillus coli communis?—Yes. But we were speaking of cockles before.

18105. Of cockles?—Yes.

18106. Are you referring to oysters now?—You used the word "oysters" then, but I think it was a mistake.

18107. Oysters; oh! cockles; have you changed your opinion then lately in connection with this matter since you have altered your methods?—No; I still think it is a coli-like organism and indicative of sewage pollution. Although it may not be the true coli it is an organism we always find associated with sewage or in waters that are polluted.

18108. It is sufficiently certain though to let you know that there is contamination by sewage matter?—I have got here a report I made to the County Council some little time ago, and in that I say:—"The above results show that the Leigh cockles show no more signs of pollution than did those from Carnforth, and either both were sewage polluted, or the tests upon which we usually depend for detecting sewage pollution are fallacious. That such is the case is also indicated by the results of certain researches in the Thompson-Yates Laboratory at Liverpool, and published in Vol. II. of their reports. In the present state of our knowledge, therefore, bacteriology cannot be depended upon to indicate whether shell fish are polluted or not with sewage. This result is also confirmed by a series of experiments I have made with oysters from various sources. The Local Government Board should be requested to have the bacteriology of shell fish and sea water thoroughly investigated. At present, therefore, we are thrown back upon the examination of the cockle beds and layings, and the result of experience." That was my opinion in February when I reported to the County Council; of course one has had little more experience since then.

18109. What would satisfy you now that sewage was present?—Well, before I would certify it from a bacteriological examination I should want all the tests which I have just enumerated, but in my own mind I would feel fairly satisfied if I got all the results which I have previously had.

18110. In your own mind you would be satisfied?—Yes.

18111. (*Sir Michael Foster.*) You are ready to accept mere bacteriological evidence independent of any topographical evidence?—I think that if you get indubitable proof of the presence of bacillus coli and of the bacillus enteritidis, it would be intensely surprising if the topographical examination did not show the presence of sewage.

18112. Would you be prepared to trust the former alone; are you perfectly sure that the coli and the enteritidis come from the sewer?—I do not know whether I should like to be absolutely positive.

18113. (*Mr. Stafford.*) Have you found the enteritidis sporogenes in these cases in cockles?—Yes, you find these when you do not find the coli. In a large number of cases I find the organism which gives the particular reactions, but which has not been tested on animals.

18114. Where you find B. enteritidis, and where you find these coli-like organisms, are you prepared to certify there was sewage present, although you do not find bacillus coli communis—The bacillus enteritidis only? No; I would not certify to that effect.

18115. Without the bacillus coli communis you would be prepared to certify that there was sewage pollution?—No, oh, no; because often if you do not find the coli you find the enteritidis sporogenes; I think it is probable that there has been previous sewage pollution. The presence of nitrates in the water indicates that at some time the water was polluted, but it does not follow that it is polluted at that time or to a dangerous extent.

18116. Have you been able to bring home to the Brightlingsea and Southend oyster merchants the fact of their shell fish causing enteric fever?—I think they are both fully aware of that; they realise it.

18117. You have satisfied yourself?—I think so.

18118. By investigation?—Yes.

18119. Could you tell us of any outbreaks in connection with them?—Any outbreaks in connection with them at Southend have been investigated by Dr. Nash, and I do not care to interfere with the local Medical Officer. I have met him several times, and I have samples of the oysters and cockles, and reports have been furnished, and the Southend Corporation have taken action to prevent, as far as possible, the sale of shell fish there which comes from sewage-polluted sources. They have actually given up, I think, some of their own beds.

18120. What about Brightlingsea? — Brightlingsea have abandoned certain of their beds, and of course they have put down sewage works, which have improved matters somewhat; but the beds which were most liable to pollution have been abandoned.

18121. They have satisfied themselves that they were causing disease?—They were then, but they are not now. The only outbreak since the sewage works have been completed and those layings abandoned has been that outbreak which occurred at Mistley and affected Chelmsford.

18122. (*Sir William Ramsay.*) I thought you were quite dissatisfied with the sewage arrangements at Brightlingsea?—So I was. The old sewers discharged quite close to the beds; now the sewage is carried out into the middle of the river. Besides that, the beds which were chiefly implicated in the previous outbreaks have been abandoned.

18123. (*Mr. Stafford.*) To what extent is shell fish the cause of enteric fever, do you know, in the towns in Essex?—Do you mean the number of cases?

18124. The percentage of cases due to shell fish as compared with those from all causes. The number of cases in which there is a fair presumption that it is due to shell fish I should say is small. I would not like to say what, but on going through the reports for the last few years I could get the numbers.

18125. You would not say that it was 50 per cent. at Southend?—At Southend?

18126. Yes?—No, I should not.

18127. Or at Brightlingsea?—Nor at Brightlingsea.

18128. You would not like to hazard an opinion as to what the percentage was?—No, I should not, it is too hazardous. Dr. Nash, I believe, thinks that a large proportion of the cases does arise from shell fish, but when I investigated an outbreak which occurred there some years ago I went into every house in which an outbreak had occurred and made personal investigations, and as far as I remember there were not 5 per cent. of the patients who had eaten shell fish at all during the period when they would become infected.

18129. As regards River Boards as being the authorities for supervising the storage and sale or registering shell fish, would not that be passing over the local sanitary authorities?—It would, no doubt, to a certain extent. Of course, that is a subject I do not like to say too much upon.

18130. But you think you would rather on the whole have an independent authority?—I would.

18131. Perhaps you think that the sanitary authorities themselves are rather involved in this question?—I think the more thoughtful members of these authorities would rather it was in the hands of an independent body than in their hands.

18132. Would there be any difficulty in the Medical Officer of Health acting independently of his own local sanitary authority?—It is a very difficult matter for a medical officer of health to act independently of his sanitary authority.

18133. But if this matter is handed over to the Rivers Board I presume a medical officer of health must be consulted about the pollution of these estuaries?—Quite so; but it may be a very different matter giving them information, and making reports to his authority, and his authority taking action upon them. The difference would be in the action taken on the presentation of the reports, not on the reports themselves. I think the medical officer of health is strong enough; he would make the same report in both cases, but the one board would be very much more likely to take action than the other.

18134. But has the medical officer of health to report in those cases?—If the Rivers Boards were the authority in those matters, he would report to the Rivers Board, I presume.

18135. Would that not get him into trouble with his local sanitary authority?—He is often getting into trouble with his local sanitary authority; that would not be anything fresh.

18136. You think he would not mind that?—They have got accustomed to it.

18137. (*Sir Michael Foster.*) This Rivers Board would be the sanitary authority *qua* wherever water was concerned?—Quite so.

18138. And so far as water was concerned the sanitary authorities would really have nothing to do?—Streams and rivers? Yes, they do so little at the present time that they cannot complain if someone else steps in and does it for them.

18139. (*Colonel Harding.*) Have you any doubt as to the wholesomeness of uncontaminated shell fish?—Of uncontaminated?

18140. Yes?—No; if you are referring to oysters I partake of them whenever I have the opportunity; I never have any qualms that they are likely to do me any harm.

18141. Have you the same confidence in mussels and cockles?—No.

18142. I mean quite apart from the question of contamination?—I should have every confidence in cockles; but one has heard so many cases of poisoning occurring from mussels I certainly should not have the same confidence in them.

18143. (*Sir Michael Foster.*) There is a disease something different from that which is caused by mere sewage contamination?—Quite so.

18144. (*Colonel Harding.*) There is no danger of enteric, except from sewage contamination?—I think not; I have never had reason to suspect it.

18145. (*Sir Michael Foster.*) But apparently there is evidence with regard to mussels that certain changes do take place in the mussel which create a special disease when they are eaten?—I think there is no doubt of it. I did have one case of enteric notified, and which I considered was not enteric at all, but mussel poisoning; in fact, the medical man himself said afterwards the notification was a mistake.

18146. It was rather in the nature of ptomaine poisoning, I suppose?—Yes, it was.

18147. (*Chairman.*) Just one question on filtration; have you any experience of the filtration that waterworks companies adopt?—Yes.

18148. And have you examined the final filtrates they have got at all?—Well, I have examined the final filtrates for about half-a-dozen different water companies every month for years.

18149. Now, with their filtration I suppose they can get as good a filtrate as any land filtering could do?—The drinking water.

18150. Yes.—They can, but, of course, it requires very careful supervision. That is where they are constantly breaking down. We get water for, say, 10 months in the year perfectly satisfactory; perhaps twice out of the 12 months it is quite unsatisfactory.

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18151. All I wanted to get at is this—that artificial filtration can produce effects as good as you can want?—I can produce practically a drinking water from sewage. I have got a small filter, about a foot high, on my laboratory bench, which I am constantly putting sewage through, and I can oxidise the whole of the ammonia of nitrates, and you may be surprised, but I can get a sterile effluent; but it is not practicable on a large scale.

18152. (*Colonel Harding.*) You mean not practicable because of financial considerations?—Yes; there is only a bed of polarite and sand, and below that there is a small bulb of earthenware which I got from a Manchester firm. It was useless for some time, but I got some sand from a filter-bed which was nitrifying very rapidly, and mixed that with the other material in it. For the last four or five months it sim [illegible] trifce the whole of the ammonias.

18153. (*Sir Michael Foster.*) And the effluent contains no organisms whatever?—It is practically sterile.

18154. No nitrifying organism?—No; they do not come through the porcelain.

18155. (*Sir William Ramsay.*) The water filters through poreclain?—Yes.

18156. (*Sir Michael Foster.*) A kind of Chamberlain filter?—The porcelain is a bulb at the bottom of the vessel containing the filtering material; I pour the sewage on from time to time. Of course, if I were to deluge the whole thing it would come through with ammonia in it, but put on perhaps half a gallon in a day, that would filter through, and it is almost drinking water.

18157. If you eat an oyster which has been exposed to sewage contamination and contains bacillus typhosus, the danger of eating that oyster must be very different if the oyster only contained three or four bacilli or if it contains a million?—Undoubtedly.

18158. And yet the evidence that we have as to the presence of the organism in the oyster is simply its presence, and not the amount of it?—Very rarely have we got any evidence that has proved that they were actually present, I think we examine for the baccillus coli.

18159. You mean where there is evidence of bacillus coli being present in the oyster, we are only told that it is present?—Quite so.

18160. It might have been the presence of one bacillus which produced the result?—Yes.

18161. Well, is it not very desirable that, in estimating the bacillus in an oyster, we should know, not simply that it is present, but in what numbers it is probably present?—I think it would be better to know in what proportion of oysters an organism is present rather than the quantity that is present in one oyster.

18162. Then I am wrong in supposing it makes a difference whether there is one or a million inside?—If you have opened a good many oysters you will find, in some very little liquid in the shell, one cubic centimetre; you will find in another 10 in; but, of course, the liquid is always poured off before the oyster is eaten, and I prefer, roughly, in giving an opinion, to make an incision into the gland of the oyster, and take a small portion of that with a sterile forcep.

18163. Have we any evidence of the bacillus coli, or of any other coli, passed into the tissue of the oyster? It is confined to the two chambers and to the intestines?—I think so.

18164. So that you might get no result if you opened the tissue—if you cut into the tissue of the oyster with a sterile instrument?—If you cut into the tissue of the oyster you will always find in a second or two a considerable amount of liquid comes into the cavity.

18165. That is the tissue liquid?—Yes.

18166. Therefore, properly is free from all extraneous organisms?—If you find the extraneous organisms in the shell, I think in 99 per cent. of the cases you will find them in the body fluid.

18167. Have you made observations to that effect?—Oh, many.

18168. Very carefully?—Yes; they have been done by myself.

18169. Roughly, of course, the liquid outside would get mixed with the sewage?—I have never sterilised the outside of the oyster.

18170. I am speaking now of a liquid in the tissue itself?—Yes, I should drain off the liquid; the oyster bulges over perfectly smooth, and very little liquid adheres to it, and I cut through this.

18171. You are cutting an intestine, possibly?—That is the object—to cut through the gland and the intestine as well.

18172. Of course, if there is a bacillus in the intestine, it is in your result?—Oh, yes.

SIXTY-FIRST DAY

Thursday, 11th June 1903

PRESENT:

The Right Honourable the Earl of IDDESLEIGH (*Chairman*), presiding.

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P.
Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E
Mr. W. H. POWER, C.B., F.R.S.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS (*Secretary*)

ALSO PRESENT:

Dr. A. C. HOUSTON, M.D.
Dr. H. T. BULSTRODE.

Prof. W. A. HERDMAN, D.Sc., F.R.S., called; and Examined.

Prof. W. A. Herdman, D.Sc., F.R.S.

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18173. (*Chairman.*) You are, I think, Professor Herdman?—Yes.

18174. May I ask you whether you consider it possible for shellfish to be contaminated, and to become injurious to human beings?—Certainly.

18175. Could you give the Commission any experiences of your own on the subject of the contamination of shellfish?—Do you mean on the subject of shellfish becoming contaminated with sewage? Well, yes, we have undoubted cases in our sea fisheries district of shellfish becoming contaminated with sewage.

18176. What district are you alluding to?—Lancashire; what is technically called the Lancashire and Western sea fisheries district; if you want a specific instance mentioned, I would mention Egremont. I believe it is a known case; it has got into the papers lately; I know the locality personally.

18177. (*Sir Michael Foster.*) What was the case there,

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very briefly?—It was mussels that were very badly polluted. There was an inquiry, and it was perfectly well established that the shellfish were polluted by sewage.

18178. And it gave rise to enteric fever?—Yes, and there were several cases of illness and at least one death.

18179. (*Major-General Carey.*) Egremont in the Mersey?—Egremont in the Mersey, yes.

18180. (*Chairman.*) In this case that you are mentioning, was there a sewage outfall in close proximity to the mussel bed?—Yes.

18181. Do you know at all the greatest distance between a laying bed and a sewage outfall at which contamination has been proved?—Oh! that would depend entirely upon the lie of the land, the tidal and other currents of water. There is no point in the distance, as the distance would differ very greatly under different circumstances on different coasts; even at different periods of the month, that is to say, it would depend upon the strength of the tide, and upon the difference between neap tides and spring tides.

18182. Do you imagine that contamination can be carried through any considerable extent of sea water?—Yes, I imagine it might be carried several miles; if you call that a considerable distance?

18183. (*Sir Michael Foster.*) Have you instances of that, or on what do you base your opinion?—No, I am basing that opinion on general grounds, on one's knowledge of estuaries and of the way in which things are carried. Perhaps, I might say, that it has been a considerable part of my work during the last 20 years or so to tramp the shores of this country and other parts of Europe, and I have had considerable experience in the action of tides, and, have made some experiments with floating bodies. what we call drift bottles and other floating bodies, and arguing from that general knowledge, and from the results of these experiments with floating bodies and bodies suspended in the water, I should say the sewage certainly could be carried several miles, although I do not recollect a specific case of shellfish contamination from sewage at that distance.

18184. (*Chairman.*) No, but you would declare the opinion that there would be a possible danger of it?—Yes, where there happened to be strong currents.

18185. (*Sir Michael Foster.*) That is to say, not only certain constituents of the sewage constituents can be carried that distance, but that germs in the sewage might retain their vitality?—If the germs are in particles of the sewage, I do not see why they should not retain their vitality. You see the distance might be covered in quite a short time in a strong current in an estuary.

18186. (*Chairman.*) Have you ever examined shellfish yourself to see if they were contaminated?—Oh, yes, very often. Are you talking of bacteriological examination or general?

18187. Bacteriological examination?—Well, in regard to bacteriological examination, I should like to say I do not consider myself a bacteriologist, although I have worked along with bacteriologists on many occasions. Some of my assistants have been bacteriologists, and I have directed the general enquiries, but I do not consider myself to be a bacteriologist.

18188. But at any rate you have been present at bacteriological examinations?—Oh, yes.

18189. Do you consider that the presence of the bacillus coli in oysters is a proof of contamination?—I should like to take it along with other proofs. I do not think really, as far as I know the bacteriological results at present—I do not think one could say, that taken by itself, and not in very great amount, that it was an absolute proof.

18190. You mean it might have come without contamination?—I think that we want further knowledge as to the distribution of coli in nature not only in shellfish.

18191. You mean that there might be a bacillus coli in the oyster itself, not derived at all from human beings?—Quite so, it might conceivably be derived, let us say, from fish or birds. I do not know that it is, but I say it conceivably might be. I do not know whether you know the recent work of Professor Fuller in America, at Brown University, in which he has stated that coli does not occur naturally in the intestine of the oyster. That of course was also a possibility—that it occurred naturally in the intestine of the oyster. Well, this work of Professor Fuller seems to establish that it does not.

18192. (*Sir Michael Foster.*) What is the reference to that work?—I can give you the reference afterwards; I can send it to you. The title I remember, "The Flora of the Intestine of the Oyster" by Professor Caleb Fuller, of Brown University, published within the last year—six months, I believe. He has examined very large quantities, many hundreds, I think, of oysters from Narragansett Bay, and finds that those from pure water never contain coli, and he comes to the conclusion that coli is evidence of pollution of some kind, but whether it might not possibly be pollution from sources non-human, I think is still open.

18193. (*Chairman.*) You think it possible it might be, even from fish?—I think it is conceivable. I have not any actual evidence to give you in support of that; I merely instance that as an example of what I have said before, that I think we want further knowledge of the distribution of coli in nature.

18194. May we take your opinion to be this, that suppose a laying, and supposing only a few bacillus coli were found in the water by the laying, and that there were no sewage outfall very near, you would consider the shellfish that came from that laying to be reasonably safe?—No. What I should do would be, I would insist upon a personal inspection of the laying by somebody who knew what he was doing, by a scientific man or a fisheries inspector who understood about tidal currents and who could look for naked eye evidence on the laying. I think it would be very important in a case of that kind to make a personal inspection, and I should like to say that I do not think samples should be taken for bacteriological examination by people who are not scientific men, or who have not got a sufficient training to understand what kind of samples they ought to take, what part of the bed they ought to sample, and how many different parts they ought to sample. I think you can get a good deal of naked eye evidence as to sewage pollution. If I were going to examine a case of that kind I should certainly first of all examine the Admiralty charts of the neighbourhood of the laying and of sewage outfalls, however distant they might be, and I should see what depth of water there was at different parts of the coast, how the tidal currents ran, what differences in strength they had at spring tides and at neap tides, and I should, if necessary, try some experiments with floating bodies in order to see whether that small amount of coli that you speak of meant anything or did not.

18195. I see; then in fact you would employ an expert to take the samples?—I lay great stress upon a personal examination of the beds, in fact I should consider in many instances that to be just as important as the bacteriological evidence.

18196. (*Sir Michael Foster.*) I take it, Professor Herdman, that you would treat each case as a problem by itself?—Yes.

18197. There would be a sewer and there would be an oyster laying; the problem is, is it possible that that laying is contaminated by bacilli in the sewage?—Yes.

18198. In order to answer that question you would require a very careful topographical investigation, together with a bacteriological examination?—That is so.

18199. That would be a special investigation for each case, probably?—I think it ought to be so.

18200. Because in each case there would be differences of tides and so on?—Yes.

18201. It would not be the mere distance as you said a little while ago?—There would be a very large number of circumstances to be considered, and only a scientific expert could value those circumstances: is that your view?—Yes.

18202. Do you think that if that were done then a trustworthy opinion might be formed in each case?—Yes, I think so.

18203. As to whether the layings were liable to contamination or not?—I think so. May I say with regard to a scientific expert, that I think it might be in most

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cases such a man as a fisheries inspector who had quite exact knowledge in regard to tides and evidences such as he could see with his eye of sewage contaminations, and of course in so far he is a scientific man.

18204. (*Chairman.*) Your experience has chiefly been in Lancashire; have you had any experience on the Continent at all?—Yes, I have examined most of the oyster localities in France and in Holland, and some in Italy, Spezzia, and one or two others.

18205. Is there any information about them that you could give us or that you think might be useful to us?—Well, what kind of information?

18206. (*Sir Michael Foster.*) Are the Dutch layings liable to pollution, do you think at all?—Yes, some that I have seen were not only liable but I should put it more strongly, were then polluted.

18207. Which were those?—Those were layings in the neighbourhood of Bergen op Zoom, and in the neighbourhood of a village where I stayed for some days called Ierseke, on the Scheldt.

18208. Were those oysters exported at all to England?—I understood so. That is probably easily ascertainable; but I think they were.

18209. The pollution was very obvious, was it?—It was quite obvious. I had better say this is several years ago; I do not know whether anything has been changed since. This was at a time when I undertook to visit these places for our Sea Fishery Committee in Lancashire, and I wrote a report upon the matter at the time. It is several years ago now; but they were very badly polluted, I then thought.

18210. (*Chairman.*) Have you got any opinion as to this. Suppose a polluted oyster came over to England, and was placed in clean water, how long would it take before it ceased to be a source of danger?—Well, Professor Boyce and I made a number of experiments some years ago on that very point, which we published. I am afraid I cannot recollect what number of days it was, but we have stated it in print, and it was the result of a considerable number of experiments.

18211. (*Sir Michael Foster.*) Was it not ten?—Yes, probably it was. Would it be sufficient if I referred you to that statement which we made,*and add that I have seen nothing to alter my opinion since.

18212. Were your oysters in these experiments put in as natural condition as possible?—We had them both in our laboratories at University College down in cellars to keep them cool, and we also had them at the biological station at Port Erin, in the Isle of Man, where we had absolutely pure sea water.

18213. And subject to flow?—Yes.

18214. (*Chairman.*) Do you think that the law about shell-fish in England requires amendment?—Well, there is one point I wanted to make a suggestion in regard to, and that is a suggestion that the Sea Fisheries Committees—the District Committees—should be given an opportunity of being present at any inquiry that is going to be held in regard to new sewage schemes, in order that they might represent their views if necessary. Would that come under what you ask me, is that the law you mean?

18215 Well, I do not know whether you have seen any of the former reports of our Commission. In our last report we recommend that the country should be divided into a certain number of districts, say fifteen or sixteen, something like that, and each district placed under the charge of a Rivers Board so far as the pollution of water is concerned, and that there should be a central authority in London to which appeals should be made. Now would you be of opinion that if such Rivers Boards were created they would be proper tribunals to look into oyster laying and shellfish?—How would they be constituted, these Rivers Boards; would they be like our Sea Fisheries Districts?

18216. They would probably be combinations of county councils?—Yes, that is, like the Sea Fisheries District Committee.

18217. Yes. Well, of course, there are three Rivers Boards now in existence, the Mersey and Irwell, and the West Riding and the Ribble?—I rather deprecate putting that power entirely in the hands of local bodies, because local interests come in so much.

18218. There is always an appeal——

18219. (*Sir Michael Foster.*) This is a large local body representative of a rivershed or more?—But, still, the representatives on it might be particularly interested in a particular estuary, might they not?

18220. Yes; but on the other hand I imagine that the Fishery Committees might be directly represented on that body?—Yes.

18221. If that were necessary in order to ensure harmonious working between the two, you say this body would have the responsibility of all sanitary matters as regard water, either fresh, brackish, or saline; and, therefore, must deal with it as a whole?—Would this body be acting in the interests of the sewage schemes or of the fisheries?

18222. It would be acting in the interests of the public health?—In the interests of the public health. Yes, I think so much depends upon how you arrange the constitution of the body.

18223. It would have to be constituted so as to have for its sole object the public health and the good of the nation, because it would have to deal with other industries besides those of fishing?—Chemical.

18224. It would have to deal with manufacturing interests, and while not over-riding the manufacturing interests, it would have to see that these would be subordinated to the public weal?—I have heard so much about the conflicting interests of sewage and shellfish amongst local people that one feels that it would be very much safer to take the decision of any particular cases out of the hands of a purely local body.

18225. Are you not straining the words "purely local"?—Probably I am; does not that depend upon the degree——

18226. (*The Secretary.*) Might I just point out that probably the conflicts of which Professor Herdman is speaking have arisen between sanitary authorities, whose duty it is to make sewers, and the fishery people. The county councils are not sewer-making authorities, and as they would be the people from whom the representatives of the Rivers Boards would be obtained, probably those conflicts would not arise between them and the fishery people?—But you might have individuals on this Board who were owners of layings in the estuaries, or who were largely interested in the local sewers.

18227. (*Sir Michael Foster.*) Or interested in other manufactures?—Yes. They must act as public men.

18228. (*Chairman.*) You see the Central Board is always there if an appeal seems desirable?—Well, so long as you allow an appeal to the Central Board, then, I think, perhaps, that safeguards sufficiently.

18229. (*Sir Michael Foster.*) Oh, certainly; that is part of our recommendation?—Well, then, what I would propose——

18230. This body is essentially a sanitary body?—The local body you are speaking of.

18231. The large local body?—The large local body.

18232. Whereas your Fisheries Committees are not, necessarily, sanitary bodies, are they?—Oh, no, they act in the interests of the fisheries, in the interests—well, I was going to say of the trades concerned; but I will not quite say that, because the interests of the fisheries might not be the interests of the trade at the moment: they act in what they consider to be the interests of the fishing industries, not for the present only but for the future.

18233. (*Sir William Ramsay.*) But may I point out that we have had evidence to show that the Fishery Boards do not trouble themselves about the results of eating diseased oysters, but only about the health of the fish which they look after; that the oyster itself is not diseased, but may produce disease in man; it is not their business to produce that remedy?—Quite so; they have nothing to do with the public health.

18234. (*Sir Michael Foster.*) It is a question of public health, is it not?—Yes, but I should like to press my suggestion that the Fisheries Committee ought to be given some power or right to be present at any inquiries, or to take part in any proceedings in regard to the installation of new sewage schemes, because for this practical reason that the Sea Fisheries Committees have men—

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have officers—who are patrolling the coasts constantly, who know these shellfish beds and layings much more intimately than I think any other authority can pretend to do.

18235. (*Chairman.*) Our Fishery Committees know the layings better than any other authority?—Yes, I think so. May I take, as an example, our particular district in Lancashire, where we have a superintendent of fisheries, and under him there are a number of bailiffs. Each bailiff has his own area of coast assigned to him. It is his regular work to inspect that area; he has to be familiar with the fisheries, shellfish and others, on that coast; to know their condition from week to week; to send in a paper in which he gives a report on their condition. He knows of any changes in the sewage in relation to the beds, I will not say pollution of the shellfish—he is not a scientific specialist; he may not know quite what constitutes pollution of the shellfish, but he knows any changes in regard to the run of the effluent over his shellfish beds, so that he can report to his superintendent. He also knows about the tides and the set of other currents due to prevalent winds and so on. Therefore, I should submit in a word that the Sea Fisheries Committees are in possession of information which enables them to represent better than anybody else what will be the probable course of any new sewage matter discharged on that shore.

18236. (*Sir Michael Foster.*) They should always have an opportunity—a *locus standi*?—I think so.

18237. Of giving their opinion on the matter?—Yes before the scheme has gone too far; they ought to come in I think, at an early period.

18238. If in any of these large districts we are speaking of there was a large Sea Board it might be desirable that the Fisheries Committee, having charge of that Sea Board, was represented on the Board itself?—Yes, so long as it is represented as a Sea Fishery Committee and not merely certain individuals taken from the one Board and put on to the other.

18239. No. I mean directly represented as a Fishery Board?—Yes.

18240. (*Chairman.*) Do you think it would be possible to arrive at anything like a standard of purity, and say in the water round the laying came up to such and such a standard the laying might be pronounced safe?—I think it would be very desirable indeed, because there are many different opinions held at present, but I am not at present prepared to state what such a standard should be.

18241. But are you prepared to state that you think it possible to arrive at such a standard?—I think the attempt should be made.

18242. (*Sir Michael Foster.*) But what you said to me a little while ago was rather against any standard at all?—What was that?

18243. It was rather that each sewer and oyster laying should be regarded as a special problem to be worked out on its own circumstances?—I do not think the two statements are contradictory, are they? I certainly said that each should be worked out as a special problem; but suppose you have worked it out and you find that there is a comparatively small amount or a comparatively small possibility of pollution, I think agreement might be arrived at between authorities as to whether that comparatively small amount was to necessarily condemn that laying.

18244. But the problem really is, is it not, whether certain germs can arise and remain in a living condition in the laying? And you think that if there is a possibility, however remote, of these particular germs being present, then that laying ought to be condemned?—I think that is going pretty far. I think you will agree we cannot have all our food and drink absolutely sterile; all we can aim at is an approximation.

18245. I mean you want to be absolutely free from the typhoid bacillus, do you not?—Yes. Of course, in so many of these cases it is not the typhoid bacillus which you find, it is other accompanying things which show you a possibility of typhoid sometimes being present.

18246. Yes, but I say the problem is to be sure that the typhoid bacillus does not get there and remain there in a living condition, in an active condition. All your other facts are simply evidence bearing on that problem. You have to decide really, is it not, what is possible?—I think it is remotely possible for the typhoid bacillus to get in to almost any shellfish anywhere. I think if you put it that way as to whether it is possible or not, I am afraid that is condemning, I mean, every laying round the coast of our populous country.

18247. Can you really say as much as that?—"Possibly" I think was the word you used, was it not? You must remember, of course, that these beds have to be near towns; that we cannot lay them out in deep water; they generally are in estuaries.

18248. Yes?—I think you must take a certain small amount of risk.

18249. Can you help us to define that risk in any way?—No; I think that is very difficult.

18250. But there again the definition would not depend upon any bacteriological standard, would it? It would be an appreciation of all the circumstances of the case?—Yes. I should lay just as much stress upon the other evidence as upon the bacteriological, upon what you spoke of just now, the personal inspection, and the working out of the problem of each bed by itself.

18251. Would it not be possible under those circumstances, without attempting any numerical standard of any kind, to form out of the circumstances an opinion as to whether the danger in this or that case was a real danger or not?—I should be able to form my opinion, but whether you, examining the same bed, would come to the same conclusions I do not know. I do not know whether we could get agreement between different men. I mean I should be able to form an opinion as to whether I should be willing to eat these oysters and take the microscopic risk that there was, but whether others would come to the same conclusion I cannot say.

18252. How would it work out,; could you give one or two cases; one which you yourself would say now is a dangerous case; the other circumstances would convert that case into a case in which the danger was microscopic?—I am giving you a hypothetical case; I am not speaking about a particular bed.

18253. Yes?—Suppose I examine a laying of oysters, and suppose I find the nearest sewage is about three miles up the coast, and that the lie of the bottom of the sea is such that the current of water on the ebb tide carries that sewage out into a channel of deeper water, which is a considerable distance outside my oysters, and that I find the incoming tide does not carry back that sewage, but brings in clear water from round the corner, and that therefore my oysters are practically in pure water, but that I find that about once a fortnight, during spring tides, when the current is a good deal stronger, then it brings in a certain amount of water from further out, from this channel into which the sewage, I am supposing, has been carried, and that if the time of spring tides happened to coincide with a strong S.W. wind, it would certainly drive a good deal of the outside water in upon my oyster bed. Then there would be a possibility of sewage contamination, but I consider it pretty remote. I consider if I lived near there I would, under most circumstances, be willing to eat these oysters.

18254. (*Major-General Carey.*) Do you consider that such a bed, under those circumstances, should be registered?—I should like all beds to be registered; you mean, would I pass that one for registration?

18255. You suggest a bed should be registered if found satisfactory?—Yes, I would.

18256. (*Sir Michael Foster.*) You mean if an epidemic of typhoid fever was coincident with the S.W. wind, and the tide, the danger would be very considerable, would it not?—It would then, yes. Well, but that is just a case where you would at once close that very bed. That is a point I wanted to suggest, that sea fisheries authorities should be given power to peremptorily stop the taking of shellfish from any particular bed—oysters, cockles, mussels, whelks.

18257. Not the sea fisheries authorities?—Yes, the sea fisheries authorities; I would allow them to peremptorily stop the matter until it was inquired into.

18258. But I do not quite understand whether you would register this bed as safe or not?—Yes, I would register it.

18259. But, as I suggested, if there is an epidemic of typhoid fever?—Then I would close it. I would have registration combined with the power of closing.

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18260. For the time being ?—Yes.

18261. Would you insist on very close accordance between the authority for closing a bed and the sanitary authorities of the town ?—Yes ; I think that ought to be.

18262. I see you may have, so to speak, beds which were registered as safe, but always liable ?—But under a constant inspection.

18263. Not only under a constant inspection, but under such circumstances that the registration might be recalled at any moment for temporary purposes ? — I think that must surely always be the case with registration, because you have a possibility of changes taking place on your sea coast, you know that a storm may upset the normal run of a current.

18264. I see, and then it would be temporarily suspended for that purpose too ?—I think if you registered beds you must certainly have a proviso that you can peremptorily stop the sale.

18265. What amount of inspection do you think would be satisfactory ?—Well, I think that, as I said a little while ago, the sea-fishery bailiffs have more opportunity than anyone else of being personally acquainted with any changes that are taking place in the beds ; they can report week by week. Whether it would be necessary to have any further inspection until these men report the change I do not know.

18266. Would they report changes of currents ?—Yes.

18267. And sets and so on ; they would be able to do that ?—Yes

18268. So that that would provide ample material for the authority to decide whether, for instance, a more complete investigation was necessary with the view to suspension ?—Yes, they report to their superintendent—the fishery superintendent of the district. He would then report to this local authority that you speak of, and say there has been a change in such and such a bed ; " the current is now running in a different way to what it ran before, you had better see to this." That I would suggest as a workable way.

18269. That might be reported to the sanitary authority? —To the sanitary authority.

18270. The sanitary authority would at once investigate the matter, and say whether the change was so large as to necessitate temporary suspension ?—Yes.

18271. Just one word with regard to these Dutch layings ; are not the oysters brought in from Holland under a certificate of purity ?—I think that is so.

18272. Do you know when that was the case ?—Well, it has come back to my memory now that after my visit to Ierseke I did receive from some of the men I had seen there some printed matter. I think it was to the effect that the sewage did not go into the oyster ponds, or what they call *putten*, I think, or some such name ; but was pumped separately into the Scheldt. Well, whether that is sufficient evidence or not I do not know. Perhaps I had better state a little further what I did see there. There were no closed drains, or, at least, there was not then, only down at the bottom of the ground attached to a cottage there would be a wooden privy which opened freely into a little ditch running at the foot of the ground. Then these ditches joined up, and then I believe this material is eventually pumped from one of them. That amount which does not simply soak away and find its way anywhere is pumped into the Scheldt. But in addition to that I saw fæcal matter on the shores of the actual ponds—the *putten*—they are the artificial ponds in which the oysters were. I saw the process of pollution going on ; I did not think the inhabitants were sufficiently careful.

18273. So that, supposing any legislation takes place with regard to our own oysters—native oysters—there ought to be great care with regard to the importation of foreign oysters ?—Yes.

18274. Certainly from Holland, if not from elsewhere ?—Yes.

18275. Have you experience of other oysters being imported into this country—Portuguese ?—French and Portuguese.

18276. Are they liable to pollution in anything like the way you have said the Dutch are ?—No, I think not. I have seen the French and Portuguese at Arcachon. I think they are under very good conditions, but, by the way they do not come from Arcachon actually to be eaten so that I do not think that is perhaps a case.

18277. (*Sir William Ramsay.*) Would not the danger be minimised by insisting that all foreign oysters should be laid down for three weeks or a month ?—I think it would.

18278. (*Sir Michael Foster.*) Are the oysters coming from the Auray River laid down ?—I have seen them coming from the Auray in Brittany.

18279. Are they liable to pollution ?—I do not think so ; the ones I saw there were far from any village ; they are not near Auray itself ; they are some miles down the river—down the estuary.

18280. Then with regard to the general question. I understand your view is that all these oyster layings—and I suppose we may say the same of mussel layings ?—Do you mean in this country ?

18281. Should be registered ?—Cockles, please add them also.

18282. Are cockles laid down much ?—Oh no ; cockles grow naturally in sand banks ; but you must not use the word " layings " in regard to mussels—they also grow naturally.

18283. Yes, but they are also laid down, are they not ?—Yes, they are laid down sometimes, but I think most of the ones I know grow naturally.

18284. We might confine ourselves to oysters in the first instance. Your view is, then, that all oyster layings should be registered ?—Yes.

18285. That they should be subject to constant inspection ?—Yes.

18286. And liable to temporary as well as permanent suspension ?—Yes.

18287. When changes occur ?—Yes.

18288. Information with regard to these layings of a most useful kind can always be provided by the Sea Fisheries Agents, and ought to be made use of ?—Yes.

18289. That with regard to any particular laying on any particular surfaces, the problem presented there is a very complex one, which requires very careful investigation of the topography of the currents, and so on, before a judgment can be laid down ?—*May be* a very complicated one ; I mean in some cases that it might be quite obvious, but in others it might be very complicated.

18290. May be, yes ; and that a certain standard should be aimed at in reaching that judgment ?—Yes.

18291. But you are not able to give us any help as to the fixing of the standard ?—No ; I should say that would require a conference between people who had done actual work in the matter, and who would discuss particular cases, and say, " Well now, this is a fair case to take for the standard." That is the sort of way I should arrive at it.

18292. What is your idea of the terms of the standard ; in what terms is the standard to be put down ?—I see what you mean : as to whether it should be bacteriological terms ?

18293. Yes. I gather from what you said that a bacteriological definition is of very little use ?—That would not satisfy me quite.

18294. At all events, that cannot be used as a standard ? I am not prepared to say what terms one could put the standard in.

18295. I mean it is not distance ?—No, it is certainly not distance ; certainly not—no.

18296. And it is not the result of the bacteriological examination ?—Not wholly, although I take that into account.

18297. You take that into account too ; you take everything else into account in forming a judgment ; but in what terms can you employ for a standard ? —No, I am not prepared to say just now in what terms one could express a standard, but I should like to see the thing attempted. The way I would tackle it would be, I would have the matter discussed by experts, and see whether they could hit upon terms.

18298. (*Sir William Ramsay.*) Could not it be done, to quote the old example, very much in the way that the standard of the inspectors under the Alkali Act was worked, "All reasonable precautions should be taken," and that leaves the word "reasonable" open, and then they put as a maximum standard that not more than five grains acid per cubic foot of air should go up the chimneys. Well, we might say that not more than one coli should be found in ten cubic centimetres——

18299. (*Sir Michael Foster.*) That is accepting the bacteriological standard ?—Yes.

18300. (*Sir William Ramsay.*) Leave it to the inspectors; it gradually becomes a workable standard in the course of time ?—You see I should like to suggest that it would be perfectly possible in a particular bed to have less than one colony of bacillus coli in ten centimetres, and yet have a considerable chance of pollution. It would entirely depend on when and where you took your sample; what state of the tide, &c. you took it at.

18301. But you must make some sort of maximum ?—

18302. (*Sir Michael Foster.*) You do not say ?—I did not say that I could actually give it to you in words and figures, but I think it is possible to arrive at it.

18303. I suppose there is a certain amount of coli that you would say would actually condemn ?—Oh, yes, if there was a large amount of coli.

18304. You possibly would condemn it at once ?—Yes, I agree.

18305. The oysters probably live on sewage, do they not ?—Well, I think mussels more than oysters. Mussels certainly flourish; get very fat, grow larger near a sewage fall than they do elsewhere. I have seen them up a sewer pipe of very large size.

18306. Is there any evidence that sewage, at all events, polluted up to a certain extent, is injurious to the oyster itself ?—No, I do not think so.

18307. I suppose the suspended matter of a certain size, so that it will not be rejected by the palps, would pass into the intestine and be digested ?—Yes.

18308. Probably an oyster living in sea-water containing a quantity of sewage would remove that sewage ?—Would make use of it as food, yes.

18309. (*Sir William Ramsay.*) Can you tell me if it is possible for the bacteria to remain in the interior of the oyster after the oyster has ceased to live in polluted water; would the coli remain in the intestines of the oysters for some time ?—Oh, yes. I think before you came in I answered a question somewhat similar to that and referred to some published experiments on the matter by Professor Boyce and myself some years ago, in which we gave the actual number of days.

18310. (*Sir Michael Foster.*) The bacilli are chiefly in the fluid of the pallial chamber and the branchial chamber and the intestine, are they not ?—They are.

18311. Do you know whether they pass at all into the tissues ?—No, we found none in the tissues.

18312. You examined them for that ?—Oh, yes.

18313. They really, I mean, do not go into the tissue of the oyster at all ?—I think not.

18314. You never found them ?—We never found them. We specially looked for them, so that they practically are really—the larger number of them, at all events—in the fluid of the pallial chamber.

18315. And the branchial chamber ?—Yes; and in the intestine.

18316. In the intestine; they do go much into the intestine, do they ?—Yes.

18317. When a person eats an oyster he swallows a good deal of the fluid; there is a good deal of the fluid left, and it is possible that it is this fluid which carries the typhoid bacillus in this case ?—I daresay it is in many cases. I am not prepared to say that it would remove all the risk if you were to wash out the palial cavity and remove the gills

18318. But probably the greater part of the mischief is there, is it not ?—Probably it is.

18319. Have you any knowledge about the rate of flow through the oyster ?—No, I do not think anybody knows that; you mean through the intestine ?

18320. No, I do not mean through the intestine, I mean through the pallial cavity ?—Through the pallial cavity, no; I should say that the flow does not necessarily remove a thing. I think the particles might remain although a flow was going on. I do not suppose even if I was able to give you a figure that that would indicate that the bacteria were passed out at that rate.

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18321. No, but still I mean that the flow through the pallial space would tend to clear off the bacteria in time, would it not ?—In time, yes.

18322. There is a popular idea, is there not, that when the oyster is completely out of water there is very little flow through the shell ? I suppose there is none at all ?—No.

18323. And that at high tide he gapes and takes a fresh quantity in ?—That is certainly the case.

18324. That is the case ?—Oh, yes, the oyster remains with the valves perfectly tightly closed altogether. When out of water, if the oyster gapes at all, you may be perfectly certain that the oyster is ill.

18325. Quite so, but I mean when the oyster is lying at the bottom under the water the shell opens from time to time, does it not ?—It remains open most of the time.

18326. It remains open most of the time—slightly open ?—It remains open most of the time—slightly open.

18327 Then the fluid is always passing through it ?—Yes.

18328 That would depend on the current, I suppose, at the spot ?—No, it would depend on the oyster's own ciliary action.

18329. Entirely ciliary action, do you think ?—No, not entirely. If there is a strong current running there that will certainly affect the matter, but I mean if there was no current at all there would still be the flow through the oyster.

18330. Quite so, so that it was in spite of that flow that your bacilli remained there for 14 days ?—Yes.

18331. Really, if they had been put into a strong current, it would not have made much difference, probably ?—Well, I think it might have made a difference. I think if you were to put the oyster in a strong current any stuff there would be cleared out; but may I add that I believe what has more effect in clearing out particles is constant flapping of the shell by the oysters or any other shellfish. There are some shellfish which live where there are possibilities of mud particles getting in and affecting their gills, which appear to periodically with a great muscular effort clear out everything from their palial chambers by flapping the shells.

18332. When the oyster eats I suppose it takes everything down, does it not, that is below a certain size ? It has no selective power ?—It has no selective power.

18333. As far as you know, none at all ?—As far as I know, none at all.

18334. Oysters are laid down in certain oyster beds, layings, and storage pits, and so on, but mussels for the most part and cockles are disseminated ?—Yes, they live naturally; they make their appearance as spat.

18335. You cannot register all the cockle beds ?—Why not ? You can register those from which you are going to allow people to take; you cannot register all that exist in nature.

18336. Because there are large numbers spread in small quantities over a variety of places ?—Yes.

18337. They are not aggregated so closely as the mussels or the oysters, are they ?—But you must remember people go to collect where there is a sufficient number in a limited area to make it worth their while, so that there have come to be regular cockle beds from which the market is supplied; you can register these and inspect them.

18338. The supply of cockles comes mainly from those ?—Yes. There again the sea-fishery officers could give you exact information as to where week by week the people were taking the cockles from.

18339. (*Major-General Carey.*) Would they be liable to alteration in addition; would they take cockles from one sound locality on one week and then go to another locality in another ?—Yes, if they found that the cockles were more abundant elsewhere, and cockle beds are very liable to changes because of changes in the natural conditions. A storm may change the distribution of the cockles or they may alter from year to year very considerably.

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18340. Then it would be necessary to register the beds of cockles—all beds of cockles, no matter whether they were being used at the particular time or not, because the people who were gathering the cockles might go to the next bed in a comparatively short time?—I should say, "Do not allow them to take cockles from these next beds until they were registered." I would lay down certain limits of the registered cockle bed. I should say "It extends to three miles south of such a particular promontory," or a line drawn from a church steeple to a point out at sea, and say that was to be the limit of the particular registered cockle bed, and people must not collect anywhere else. If there is a demand for collecting on a neighbouring bed then let them apply to have the bed registered.

18341. How are you going to enforce the taking of cockles from that particular bed?—Well, the sea-fishery people could do it, but whether they are the proper people to do it, I do not know. But other things are enforced of that nature on our coasts at present; we do enforce that the shell-fish under a certain size should not be taken. You are not allowed to take cockles under a certain size; you are not allowed to take mussels under a certain size; you are not allowed to take crabs under a certain size; these laws are carried out at present—districts are policed.

18342. (*Sir William Ramsay.*) That means they cannot be exposed for sale without being detected I presume?—Yes.

18343. (*Sir Michael Foster.*) Your Lancashire fishery Committee is very well organised, is it not?—Yes, I think so; I think it is recognised as being so by the Board of Trade.

18344. You are arguing from your experience of the Lancashire coast. The other parts of the coast are by no means so well provided as your Lancashire coast?—But might not that state of affairs be brought about; is it not desirable that the rest of the coast should be organised in the same way.

18345. Quite so. You have some hopes perhaps that impending changes may bring that about?—I hope so.

18346. There would be no difficulty in making it the duty of your bailiffs and so on to report on these matters, would it not?—I see no difficulty.

18347. (*Mr. Stafford.*) What is your precise connection with this Sea-fishery Board?—Well, it is a somewhat vague one. They call me honorary director of their scientific work, and ask me to investigate any particular problem that they put before me.

18348. That is merely in connection with the Lancashire sea-fishery boards?—Yes, Lancashire and Western is the title of the district. It includes a considerable part of Wales; it is a great deal more than Lancashire; it extends over seven counties, I think.

18349. You said at the commencement of your evidence, I think, that you had a very fair knowledge of the sea-shore of England and, in fact, of Europe?—Well, I think I said I had been tramping on the shores for the last 20 years or so wherever I had opportunities.

18350. That is, investigating the shores?—Yes.

18351. What is your experience as to how our shores compare with the foreign shores as regards the laying of oysters and shell-fish generally?—Well, I do not know that there is any very noteworthy difference; I do not know that I fully understand what you desire to bring out.

18352. I want it from the public health point of view, whether you think they keep their shores where the layings of the shell-fish are, in a better condition than we keep ours?—No, I do not think so.

18353. There is no very great difference?—I do not think so, no.

18354. Would a certificate of origin from foreign layings be satisfactory, do you think?—I am not prepared to say that it would.

18355. Would it have any value, do you think, in your opinion?—I am afraid I do not know enough about it; I mean about how such certificates are obtained, to be able to give you any reliable information.

18356. You do not think that a certificate given from a foreign Government that such and such shellfish layings and that such and such places were free from pollution would be of any value?—I am not prepared to say it would be of value; I think it entirely depends on how the thing is worked; what steps the Government take to ascertain the condition of the laying before giving the certificate. You see, I do not know in the least how that certificate is obtained; it might be quite valuable or it might not.

18357. How is your Sea-fishery Board constituted?—Oh, under the Act of 1888 I think it was. It is constituted partly of County Council and other representative members, and partly of Board of Trade members, about half and half, I think. The County Council members are of course elected; elected locally. The Board of Trade members are appointed by the President of the Board of Trade on the recommendation of his Fishery officials. The Board of Trade members are, I think, supposed to be more or less practically interested in the actual fisheries industries. They are either fishermen themselves or in close contact with the fishermen.[*]

18358. I think you mentioned that you did not interest yourself at all in the question of public health as regards shell-fish?—I think that is not one of the duties of the Committee.

18359. As a matter of fact they do not interest themselves?—Well, I think as a matter of fact when they see any glaring cases they make the information known.

18360. To whom—to the local authorities?—I do not know that I can answer that question; but I think in our district at any rate, we have certainly helped the sanitary authorities by drawing their attention to cases of marked pollution; but I think I was right in saying that it is not part of our duty—it is not part of the Sea-fisheries Committee's duty to consider the public health.

18361. And you do not wish to undertake it; you do not think that you ought to be asked to undertake it?—No, I think not; I think not except that we might give the information that I have already suggested.

18362. What evidence is there that the bacillus coli or the typhoid bacillus flourishes in sick oysters or dead oysters, I think you and Professor Boyce conducted some experiments in connection with that question?—I do not think we did. We certainly did nothing in regard to dead oysters. I do not think we made any statement in regard to sick oysters. I am not aware of any evidence in regard to sick or dead oysters. It is very difficult to know what a sick oyster is.

18363. Well, Dr. Niven of Manchester mentioned yesterday in his evidence here, experiments performed by you and Professor Boyce?—Well, I will not contradict him. If that was definitely stated, then it is simply that it has escaped my memory. Of course it was some years ago that we did these experiments, and I may have forgotten.

18364. He mentioned at the same time that you stated that the bacillus was recoverable after 3 weeks in sea-water, and about the same time in the body of the oyster?—Yes, I remember that, but may I say in regard to these experiments that it is all in print and that I do not think we have changed our opinions since we wrote that paper.[†]

18365. (*Sir Michael Foster.*) Have you made any more observations?—We have examined a number, both of us, of other shell-fish—a great number—and I do not think we have changed our opinions.

18366. If you made observations on those points—on the point of the relation of the bacillus; that was the point under discussion?—No, I do not recollect that we have. I do not think I have anything further to tell you, except what is in that paper.

18367. (*Mr. Stafford.*) You could not tell us the evidence now, I suppose, upon which you arrived at those conclusions?—No; I could tell you by looking up the paper and refreshing my memory, but that is of no value.

18368. Perhaps you would send us the paper so that we may have it before us?—Oh, certainly.

18369. (*Sir Michael Foster.*) You put oysters in sewage, and then took them out and put them in clean water, and examined them from time to time?—Oh yes, if that is the point—that was the method.

18370. (*Mr. Stafford.*) It was the method?—Yes, that was the method.

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[*] It was under "Orders made by the Board of Trade under the Sea Fisheries Regulation Act, 1888."

[†] *Note* to Q. 18364.—It is correct as to sea-water, but not as to body of oyster. On referring to our book I find the time was *ten* days.—W. A. H.

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18371. (*Sir Michael Foster.*) You put them on typhoid sewage?—We did; we had typhoid material from various sources. We kept these oysters in different degrees of concentration of sewage, putting certain amounts of typhoid material into these various buckets; they were left in for various periods and then taken out and put into different conditions of water, sometimes remaining, not flowing—stagnant you may call it—in other cases with a current running through for a certain number of days. Oysters were taken out each day and examined bacteriologically. That was the method.

18372. (*Mr. Stafford.*) I see. Was that the method also by which you arrived at the conclusion that healthy oysters had a destructive effect upon bacillus.

18373. (*Sir Michael Foster.*) You never thought the oyster actually destroyed the bacillus; you thought the bacillus was not propagated and died a natural death?—That was it.

18374. I do not think you brought any evidence to show that the oyster does destroy the bacillus?—No.

18375. (*Mr. Stafford.*) It simply did not flourish?—Yes, that is so.

Mr. J. H. Barber, Secretary of the Chamber of Fisheries and the London Fish Trade Association; called in, and examined.

Mr. J. H. Barber.

18376. (*Chairman.*) You are Mr. Barber, the Secretary of the Chamber of Fisheries and the London Fish Trade Association?—That is so.

18377. And you have been largely connected with the fishing industry, have you not?—That is so, yes.

18378. Now as to the general questions of the communication of disease by polluted shell-fish, have you any experience that you can give us?—When the oyster scare arose some seven years ago, we decided that the responsibility for the pollution of oysters should rest on the contaminating party, and on that decision I was instructed to take action with a view to the closing by their owners of fisheries or pits, etc., which had been started in a polluted area and the alteration of the sewage arrangements in cases where sewage had been brought to the fishery or pit, etc. Through this action of the Chamber of Fisheries a very great improvement in the condition of the oysters supplied to the markets was effected, and it was felt that the Board of Trade might much more effectively carry on such negotiations in the remaining cases, and I was instructed to take all subsequent complaints to the Board of Trade; so far as I am aware, however, little action in that direction has been taken by the Board of Trade, and the oyster and shell-fish industries now seem to look to the new Fisheries Department which the Government has promised to bring about the desired end. During my negotiations with various sanitary authorities I have found them always willing to alter their sewage arrangements to meet the requirements of our decision as set forth above; their efforts, however, were not always attended with success, and I cannot help sympathising with those towns and villages which at our request had made large sacrifices in the matter of rates in order to instal a satisfactory sewage system, and after complying with the requirements of the Local Government Board, found their works to be anything but satisfactory. I have been driven to the conclusion that some of the systems for treating sewage now used, are only in a very experimental stage, and although the risk of contracting typhoid fever from the indiscriminate eating of oysters from the market must at present be very small indeed, I am nevertheless of opinion that on account of the rapid increase of population which we have reason to expect in the neighbourhood of oyster fisheries, &c. (which are often situated in very attractive places), some much more certain method of satisfactorily disposing of the sewage should be placed in the hands of sanitary authorities.

My experience in this matter has led me to the conclusion that sewage farms are on the whole, from our point of view, the most satisfactory, but as I gather from a very interesting paper of his which Dr. Franklin Parsons gave me that open-air system of sewage disposal may be dangerous, some system by which the sewage could be burnt or treated on land so long as the liquid portion undergoes a thorough filtration would be preferable. What I wish to convey is, that my experience leads me to distrust the various systems which are now being installed about the country, and which, it seems to me, may or may not, when completed, turn out satisfactorily, and why in either case no one seems able to say, the results some-times being that a town or village has gone to great expense which it could ill afford, only to be put to still greater expense to remedy what was to have been their remedy. I am not familiar with the sewage arrangements for London at Cross-ness and Barking, but am informed that the effluent there is most satisfactory, but my opinion set out above is based on the attempts made in recent years at country places which seem on the whole to be anything but certain undertakings as regards their efficiency.

18379. Have you noticed any peculiar circumstances attendant on cases of communication of disease by shell-fish?—Well, the principal would be that where the circumstantial evidence appeared to be strong against the shell-fish the shell-fish was taken from a place where the sewage would be considered practically crude. What I mean is that where there was any considerable margin at all of salt water there does not appear to have been a strong case brought forward. Perhaps the strongest case which was brought forward was the Brightlingsea case, which probably the Commission is familiar with, when a number of trippers were taken ill in different parts of Essex after visiting Clacton. Well, in that case I think it would be found that the oysters were traced to almost a rill of sewage, and, it would seem, that must have been a very favourable set of conditions of tide and so on for the typhoid germ as if that condition generally obtained half the country would be ill of typhoid.

18380. Does your Chamber give you any instructions as to your action about any proposed legislation on the subject?—My instructions are to watch for legislation, and to see that any attempt in that direction, is in the direction of securing the penalty, if any, on the offending party, that is to say if oysters are brought to sewage, of course the man who brings them there must be held to blame, but if the sewage is brought to the oysters the party bringing the sewage must be held to blame.

18381. Did you take any part in either opposing or supporting the Oyster Bill which was brought forward by the Government a few years ago?—Yes, we opposed that.

18382. You opposed it?—Yes.

18383. Well, now, why?—Well, because—it is rather a longtime back speaking from memory—because I think the Bill would make as we thought the oyster planter responsible for action of the sanitary authority. It would be upon those lines that we opposed it.

18384. Do you consider the present state of the law satisfactory?—Well, no, we should like the law strengthened in the direction of making it more definite, making the principle I have just set forth more definite. But I may say this with regard to oysters, the places are so few, Dr. Bulstrode has been to them all—that it is easy to put your finger upon every oyster bed on the map because it is so difficult to start a new one. The conditions have to be so nice for the fattening or breeding of oysters, and no one exactly seems to know what are the conditions favourable except by experience, that a certain place will fatten and another place will breed them. Perhaps oysters at one place will fatten three years out of five, at another, perhaps, only two years. That is only gained by experience; nobody seems to be able, so far as I can make out, to know why it is, therefore the chances of there being new oyster fisheries or oyster layings are very remote, and the Government can easily keep their eye on the oyster beds. Of course with regard to shell-fish on the foreshore that is quite another matter; cockles and mussels and so on; but with regard to oysters, Dr. Bulstrode made out a list when he went round, 1896, I think it was, and many of those cases have been dealt with; of course there are very few now remaining which require to be perfected—at least to be improved.

18385. Would you have any objection to the layings of shell-fish being registered by some authority?—Personally, I think not. I might say on this point perhaps that the only thing, speaking for myself, I would suggest should be avoided, is the publishing of the fact that a man's fishery is out of order or subject to suspicion rather than to attempt to put it in order.

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What I meant to say is this, when the oyster scare arose in 1896, sufficient time elapsed between the writing and the publication of Dr. Bulstrode's report, to do a great deal of good. If the time had been used in putting the matter right without legislation, much could have been done, as I have proved myself, by negotiation with sanitary authorities. Instead of that, it was brought up in the Press, and little is done so far as I can see, except by our Chamber with very limited means, to put the matter right. If the same energy were shown in putting the matter right as is shown in drawing attention to it, it seems to me the risk, which is now very small indeed, would be hardly worth considering.

18386. I am not sure that I quite follow that argument ?—What I meant to say is this, it has been the fashion lately through the Press, and I may say as well through the Local Government Board, to publish reports about oysters, but we have the greatest difficulty in the world in getting the Local Government Board and the Board of Trade to undertake any material steps to put these places right. It is much easier for me to go round and negotiate with the local sanitary authorities, who I have always found very willing to do anything they can, and the oyster merchants. If the Government departments had displayed the same energy in that direction, it seems to me as they have displayed in publishing reports condemning oysters– having that effect anyhow —much better results would have followed. I do not know whether I have made myself clear yet.

18387. But it does not seem to me that you could say that the Local Government Board has any duty in putting things right. They have got to call attention to the fact and then the people whose duty it is have got to put the things right; the Local Government Board are not the people to act, and so on ?—I think if Dr. Bulstrode or any other inspector, whoever he may be, were empowered to negotiate with the authorities, have a quiet talk with them, that much more good would be done than by publishing reports perhaps after several months.

18388. Well, but then in that way does it not come to this, that you think the Local Government Board should have greater powers than they have now; it seems to me that your recommendation amounts to that ?—I do not admit that they have not the power already, and that seems to me to be sufficient power. Of course it is heavy for our little Chamber.

18389. They have absolutely no power ?—To negotiate or even to give hints to local authorities, because the publishing of reports is very little use at all ?

18390. Of course they can enter into communication with any body, but they have got no power to enforce anything ?—No; I know they have no power to enforce, but all through my negotiations I found the power to enforce was not necessary. Of course we had to wait while the engineers could carry out the works. That was physically necessary, but I have always found, I think I may say I have always found, the sanitary authority very willing to meet us and do what they can, and the fishery owners themselves have often closed fisheries. Mr. Baxter, who was here the other day, has perhaps the largest interest in oysters of anybody, and he voluntarily closed at once on the publication of Dr. Bulstrode's report, his fishery at Southend. Well, he would have done that without waiting for the publication of Dr. Bulstrode's report if he had had a hint from the Local Government Board. That is one case.

18391. (*Sir Michael Foster.*) You would approve of a system by which the thing could be done without so much notice being taken in the public press ?—Yes, very much.

18392. If there was a system such as has been suggested by the chairman, the body of these various layings would be registered and under constant inspection; if anything turned wrong they would be notified, and they might be corrected without a Bluebook having been published, and the newspapers being excited. That is your opinion ?—Quite so, and the local papers being excited by a man being drawn attention to unnecessarily.

18393. That is not your own opinion, but that really of the Chamber that such a change would be desirable ?—Oh, certainly, I should say.

18394. It would be the best means of avoiding what is really almost the worst mischief of all, namely, the scare ?—That is so.

18395. Might I ask the cases in which you have been so successful in getting alterations in the sewage system with a view to keeping oysters in good condition ?—Brightlingsea, Southwick, Southend, Burnham, Leigh, Pembroke Docks, Grimsby Docks, Emsworth, and many others.

18396. What was the effect in Brightlingsea ?—They instituted a new sewage arrangement there, which was brought up to a suitable condition. I believe Dr. Bulstrode approved it on behalf of the Local Government Board.

18397. And what other case ?—A place near Brighton called Southwick. At Southwick we made representations, and they collected all their outfalls into one sewer and carried that right under the river which goes up to Brighton out to sea.

18398. I thought the laying at Southwick was still not beyond suspicion ?—I think I heard something just lately, but I ought to say now that some months ago I was instructed to take future cases to the Board of Trade; it was found expensive for us to do, and it was considered to be the Government's duty, and I took the cases there. Well, nothing has been done so far as I can see, so I take no responsibility for what has occurred say, during the last twelve months; I have not carried out any negotiations during that time; I have handed over the responsibility to the Board of Trade, and I must say that I have not been well met there.

18399. (*Major-General Carey.*) If a sewer outfall was not entirely prohibited you suggest that there should be a safe margin of salt water or sea water between the outfall and the oyster bed ?—Certainly.

18400. Have you any facts on which that opinion is based ?—Well, the principal reason for that is one I have pointed out to the Chairman at opening. A sufficient margin of salt water would seem, in the absence of anything better, to protect the oysters according to our experience during this seven years past. Of course, now that this scare has grown to such proportions, the margin should be larger; in view of public opinion from an æsthetic point of view, larger than might have been necessary before. Dr. Bulstrode, I understand, fixed a margin at Brightlingsea, and he probably now has some experience as to what would be necessary in different cases. Of course the margin would be different in the different places, varying in accordance with the amount of sewage to be treated, general conditions of tide, and so on.

18401. Do you know by actual experience that the margin has really protected the oysters from pollution ? —Yes. Well, the main test of our experience is whether or not any typhoid scare arises from a certain place.

18402. (*Mr. Stafford.*) Would it be possible to re-lay all the foreign oysters for fourteen days; are there sufficient layings; is it feasible ?—Well, of course, that would be a matter of expense for one thing.

18403. All foreign shell-fish; oysters preferred ?—Of course the principal trade in foreign shell-fish is in Dutch, French, Portugese and American. A very large proportion of American, Portugese and French fish are relaid. As to Dutch, I think they would like to sell them direct as far as possible.

18404. Yes, but suppose they were to be relaid ?—By Statute you mean; in accordance with Statute ?

18405. Well, do you think it would be feasible to have them relaid before they are consumed in England ?—It would be physically possible I suppose, it would be putting an extra expense on the oyster, and the loss by death would be considerable; it would be physically possible I think.

18406. (*Sir William Ramsay.*) It would not be very serious; it merely means putting in oyster tanks for three weeks. It might mean more oyster tanks, but they are comparatively cheap ?—It is not tanks, it is putting them at Brightlingsea, or some other place which is above suspicion for some time, and such accommodation is limited.

18407. They are practically tanks ?—They are practically tanks.

18408. They are stored for a considerable time before they are sold ?—Oh, yes.

18409. They might be sold still from the tanks ?—Oh no, they come direct from the ship to the market, and from Holland they can telegraph for what they want for to-morrow, but so far as I can gather I do not think the Dutch oysters are subject to any suspicion on account of the country being low.

18410. (*Sir Michael Foster.*) What is the difference in price between an American relaid oyster and one directly imported ?—They are about the same.

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18411. Are those relaid markedly dearer than those direct?—They are sold at different times of the year, but the price is practically the same.

18412. It does not make a material difference anyhow?—Well, you could not compare them because they are sold at different seasons. Of course at present there is practically no trade in oysters, they are only relaid to prevent death.

18413. (*Sir William Ramsay*). Would there be an serious hardship in insisting on their being relaid?—Well, I think the oyster trade now would be glad of any regulation which would restore the public confidence, provided always that there was a proper regulation, and not one for publishing that oysters are bad and not securing them from harm.

18414. (*Chairman.*) Is there anything else you would wish to say to me. I think we have finished our questions?—I should like to put on record that in my opinion the scarce has been grossly exaggerated and when it arose in 1896 I went to Mr. Berrington, who was then Assistant Secretary at the Board of Trade for Fisheries, and asked him about it, and he said that having gone into the matter, he found the risk to be less that that of riding in a hansom cab, and he was going on eating oysters, but being a medical matter they had referred it to the Local Government Board. Well, now much has been done by our Chamber, and, although not so much, perhaps, as we should like, by the Local Government Board and by the Board of Trade, to improve the conditions since then, and, of course, public opinion has had a very marked influence on the oyster traders generally, so that the risk must be very much less now than it was then. But, at the same time, public suspicion having been aroused, I think it quite desirable that something should be done to restore public confidence, and what the public require to secure them from an æsthetic and a public health point of view should be done. Of course, there must always be the risk attendant on eating uncooked food attaching to oysters, that is to say, private storage and so on, in that great care should always be taken.

18415. (*Mr. Stafford.*) Is there very much risk in private storage?—Well, that depends upon the house, of course. In connection with one very notorious case it was found afterwards that the oysters had been placed where the drain was broken, and that drain I understand was being used by typhoid patients. That came out after the scare. Of course that speaks for itself. The oyster got the blame, but really it was not the oyster laying or the fishery.

18416. It was the retail?—No, it was the place where the ball was held; it was at the house itself.

18417. (*Chairman.*) Anything that you want to add do please?—If you will allow me, I should like to also put on record that the conclusion which through a certain section of the oyster traders—it has got about all through oyster traders putting things in the papers and through the authorities themselves—that the occurrence of coli communis in oysters or in shell-fish is an evidence of the presence of sewage does not seem to be borne out by bacteriologists whom our people have conferred with, and it seems to me to be altogether a speculation.

18418. (*Mr. Stafford.*) Have your Chamber had scientific advice upon the subject?—I cannot say as a Chamber, that is only hearsay of course, but I may say I am given to understand by doctors that bacteriology is in its infancy at present.

Dr. SAVAGE, Medical Officer of Health of Colchester; called in, and Examined.

Dr. Savage.

18419. (*Chairman.*) You are Dr. Savage?—Yes, my Lord.

18420 And do you come before us representing any district?—I am Medical Officer of Health of Colchester.

18422. May I ask you whether in your opinion it is possible for shell-fish to be contaminated and become injurious to human beings?—Yes, certainly.

18421. Have you known of such instances yourself?—I have taken the histories of a large number of typhoid fever patients. In a small proportion of them I have found that they have been taking shell-fish, but I have not been able to absolutely definitely trace more than one or two—a few cases.

18423. But you have actually traced a case to shell-fish?—Which I think were probable as far as that mode of enquiry will let you.

18424. But you could not say it was absolutely certain?—No.

18425. (*Sir Michael Foster.*) Where did these shell-fish come from, do you remember—the cases that you are speaking of?—No, I cannot say that I do remember.

18426. (*Chairman.*) Have you made yourself any bacteriological experiments either with fish or the waters in which the shell-fish are?—I have made a good many of the Mumbles oysters—in that district—and of the waters I have examined a considerable number of sea-water samples.

18427. (*Sir Michael Foster.*) How many?—Well, I have some figures here of about nine different ones which I have kept very careful records of. (*See* table at end of evidence).

18428. Are these pure sea-water that you refer to?—I have got duplicate copies, some of them were sea water and some were estuary water. For instance, the first four were taken in connection with the four different oyster beds of the Mumbles oysters. One sample was taken over the perches, No. 2 over the plantations, and No. 3 were taken from what are called the "Bay" oysters, which are some two or three miles out, and the last was taken from what are supposed to be very pure beds three or four miles out. I examined the oysters at the same time, but I did not bring the figures here. My conclusions are very much the same as the other bacteriologists who investigate them, that is as regards the oysters; I did not see any of the results of the other bacteriologists who examined the water.

18429. You say "In my experience even pure sea-water will frequently contain this organism if it be examined" You mean bacillus coli?—Yes, sir.

18430. In what proportion do you mean that?—In say 50 c.c.

18431. One in 50 c.c.?—That is if I examine 50 c.c. of it, I will find the organism, for instance, that was the case in No. 4 sample.

18432. How many times have you done that?—About four or five.

18433. And where did the water come from in those cases?—Well, for instance, the one quoted in these figures is one right outside the Mumbles, No. 4; I have examined that twice. I did not bring the duplicate record of it. It is no part of this series. No. 9, is at Penclawdd, which is also supposed to be pure. I had duplicate samples of that.

18434. Is it in the open sea, or how far from land is it?—This was taken about half a mile from Penclawdd.

18435. About half a mile from the shore?—Yes.

18436. You have not taken sea-water in mid-channel or anywhere there?—Several of the other samples were taken from contaminated sea-water, sea-water in the Bristol Channel. For instance, one was taken off Penarth Beach which would be very contaminated.

18437. I want to know what your evidence is of bacillus coli frequently being present in pure sea-water. I gather from that if you were to take sea-water say in mid-Atlantic you would probably find bacillus coli in it?—That is not what I mean. I have not had an opportunity of taking it from mid-Atlantic, but I should not be surprised if I did find some.

18438. The cases you have told us about are at all events tolerably near shore and not very far removed?—Well, two of them are four miles out.

18439. (*Chairman.*) May I ask you if n your opinion the law as it stands about shell-fish requires alteration?—Yes, I think it does, my Lord.

18440. Can you tell us any particular measures you would recommend?—Well, the ones I mentioned in the summary I gave.

18441. Perhaps you would just read them again to get them on the evidence?—(1.) That the discharge of crude or imperfectly purified sewage into streams or estuaries should be prohibited. It is not justifiable to *require* sewage to be sterilized. All that is justifiable to

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require of a Sanitary Authority is that its sewage should be discharged into a stream or estuary purified to such a degree that it is in solution, non putrescible or odourless, and this apart from any question as to whether it contains specific harmful organisms. On the other hand every endeavour should be made by Sanitary Authorities to prevent typhoid bacilli or other pathogenic organisms from gaining access to sewage, by sterilization of the excreta of typhoid fever patients.

18442. Well, but now on that, if it does contain specific harmful organisms, what then as far as the oyster layings are concerned is the purification at all; is not the effluent as dangerous as the crude sewage?—Well, not quite as dangerous, probably not; but I do not think it is justifiable for the sake of the oysters to require that the sewage should be sterilized. That was the attitude that I took up there.

18443. Would you allow the oysters to be taken from this bed that was exposed to the effluent?—No, I should not; my other evidence deals with that. In this part of my evidence I am stating only my opinion as to the degree of purification that would be required for sewage, not a bacteriological one. Then, secondly, all oyster layings to be registered by a Supervising Authority. The Supervising Authority to be central and not local. The Supervising Authority to have power to inspect and take samples, with powers to suspend the industry if found to be dangerous to health, until the conditions are satisfactory. Adequate powers of appeal against arbitrary prohibition to be given. As far as possible definite standards of purity requirements to be arrived at and so uniformity facilitated. No oysters—except possibly deep-sea oysters—to be sold until they have been deposited for a sufficient time in fattening grounds of approved purity.

18444. *Sir (Michael Foster.)* Yes, but I observe you would sterilize the excreta?—Yes, I think that greater attention should be had to that. It is a simpler matter, or at any rate it is an exceedingly important matter to deal with the excreta of each individual case, rather than deal with the thing in bulk after it has all got in and forms part of the sewage. I think not enough attention is in my opinion given to that.

18445. (*Sir William Ramsay.*) Do you think that it is adequate; I mean do you think you could depend upon that?—No, otherwise if you could depend upon it these other steps would not be necessary, but I think it is a step in the right direction.

18446. How could it be done. Could you sterilize the excreta of an ordinary typhoid patient in the house or in the hospital? Would it not be very difficult?—Yes, I think it is difficult.

18447. (*Sir Michael Foster.*) Chloride of lime, or burning, or what?—I think it should be mixed up with one in 500 Corrosive Sublimate and left for two hours.

18448. How about the cases of the large discharge of typhoid bacillus in the urine during prolonged convalescence; would you make a regulation that patients' urine was always to be sterilized?—I am afraid that would be rather impracticable, I am afraid they would escape.

Then thirdly that the supervising authority should be central and not local.

18449. (*Chairman.*) Well, now have you, may I ask, seen the reports of this Commission?—I think I have.

18450. In our last report we recommended that the whole country should be divided into certain districts?—Yes.

18451. In each district there should be a Rivers Board which should have control over all questions of pollution of water, and that in London there should be a central authority to which there should be a right of appeal from anything these Rivers Boards did. Now do you consider that such authorities as those would be suitable for controlling registration of layings of oysters?—How large would they be, in Essex for instance; would they include more than the greater part of the county.

18452. I should think; our idea was that you might have something like from 15 to 20 Water Boards over the whole of England, that a Water Board would include more than a county?—In that case I should think very likely it would be if it is large enough.

18453. Have you considered whether there should be such a thing as a standard of purity for the water in which layings are?—Yes, I think there can be.

18454. Bacteriological standard? — Bacteriological standard; I do not think a chemical standard would be reliable at all.

18455. Have you formed any idea of a standard?—I am not prepared to advise the exact quantity—the statement of a numerical standard—but I think a standard of bacillus coli itself is most reliable. For instance, in these four samples that I happen to quote here—in the two contaminated ones—I could find bacillus coli in one-tenth of a c.c. and also in one-half of 1 c.c. In the third sample where there was only partial contamination, it was in 2 c.c. but not in smaller amounts. In one far out to sea in 40 c.c., not in a 10th, $\frac{1}{2}$ or 2. I have examined 300 or 400 samples of drinking water from bacillus coli and I find from it that the bacillus coli standard is a very great help. I think that applying the same analogy I should not let any oysters be put in any water where the bacillus coli could be found in 1 c.c. If you find it in 1 c.c. it would not be satisfactory, but I only advance this as a tentative standard liable to be modified.

18456. It would not be satisfactory?—No.

18457. Not if you found it at all in 1 c.c.?—No.

18458. Have you examined the waters of Pyefleet?—No, they are building me a laboratory, but it is not ready yet.

18459. Would you be guided at all in arriving at your standard by topographical considerations?—Not in regard to my standard; but in my opinion of the oysters I should be; I mean I should take that into consideration but I do not see how it would affect the standard itself.

18460. Supposing in the water in which there was a laying you found the bacillus coli in 1 c.c. regardless of topographical considerations would you say those shell-fish were not safe?—Yes, I would say they were not above suspicion.

18461. (*Mr. Stafford.*) Would not that comdemn most of the layings in England?—I have not had experience of many of them; but if so they deserve to be if they are contaminated.

18462. All; although enteric fever has never arisen from some of them and no disease is traceable to them?—Well, if I found bacillus coli in one c.c., I should regard these oyster layings as liable to sewage contamination; if so, I should consider them unsatisfactory.

18463. Although you had had no other evidence on the subject?—Although I had had no other evidence on the subject; yes, in that amount.

18464. You think the bacteriological standard one c.c. would be sufficient to condemn them?—Yes, but I only advance this as a provisional standard and it may be too high. If the standard is sufficiently low a bacteriological one is sufficient to condemn. If I found bacillus coli in less than one c.c. I would take in other factors.

18465. Apart from higher or lower standard, if you found the oysters in those particular layings where you found the bacillus coli in one c.c. had never given rise to a suspicion of disease, you would still condemn them?—Well, I believe always in taking the topographical questions into consideration, but I think I should probably. I have not, in my experience, taking a standard like that found that it usually errs if you take it low enough.

18466. You think that the bacteriological standard is absolutely reliable in itself?—If you take it low enough. I mean that is the whole crux of the question. If you take it low enough, then it is reliable.

18467. But how do you arrive at the 1 c.c. being low enough or high enough?—From the results of the analyses I have made of these different waters.

18468. How many analyses have you made?—Well, of drinking water—of all waters I suppose about 500.

18469. Of sewage and tidal waters?—Not more than about 20, I should think, of tidal waters. It is one of the things that I wish to investigate further. I would not lay too much stress upon this question of a bacteriological standard; but it is the opinion which at the present moment I hold subject to further work upon it.

18470. (*Chairman.*) Have you considered that you might find the bacillus coli apart from human beings?—Yes, I have; I am convinced that you may find it and I have found it in the excreta of sheep for instance in abundance.

18471. May you find it in birds?—I do not know, my Lord.

18472. Or fish?—I do not know; I have no experience.

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18473. At the same time it is rather a formidable thing that you propose, that water should be condemned if you found bacillus coli in 1 c.c. at all.

18474. (*Sir William Ramsay.*) You have not examined the waters of the Pyefleet ?—I have not, no sir.

18475. Would you condemn the Pyefleet if you found bacillus coli in one cubic centimetre. It is a large order ?—Well, I should say that if I found bacillus coli in 1 c.c., the water was liable to sewage contamination ; that I think would be justifiable, but my numerical standard is only a provisional one, subject to alteration with more extended experience

18476. But what steps should be taken ; I mean suppose you did so say, what steps would be taken next ; would you shut up the Pyefleet ?—Yes, unless you are going to allow sewage contaminated oysters to be used ; if you are going to run the risk of it.

18477. Or remove the oyster bed ?—It seems to me the essential thing is to have a bacteriological standard quite apart from whether you have one c.c. or not. You have to stick to it or not. It is one of the things that I was interrupted in my work leaving Cardiff that I could not go on with these samples, and I propose to do a great deal more at Colchester ; but I think a bacteriological standard could be arrived at from the water and this whether a one c.c. coli standard or a lower one is used.

18478. The bacillus coli must be absent from 100 centimetres of pure water, I suppose, would you say ?—Yes—50 c.c. If I found a water carried no bacillus coli in 50 c.c., I regard it at a high degree of purity.

18479. Not worth troubling about as a source of contamination ?—No.

18480. (*Major-General Carey*). Do you suggest that all layings should be registered ?—Yes, I do.

18481. But that from time to time afterwards they should be liable to prohibition ?—Yes, if they were unsatisfactory.

18482. If they are afterwards considered unsatisfactory by the supervising authority ?—Yes.

18483. The grounds of such prohibition might be on the topographical as well as the bacteriological examination ?—Yes ; the whole thing ; both the topographical and the bacteriological.

18484. But the public would not be protected pending the prohibition of a registered bed ?—That is a matter of administrative detail that could be got over. They could be prohibited if they were very bad, I suppose.

18485. They would be all registered, I suppose, in the first place, good or bad ?—Certainly.

18486. And that fact, I suppose, would be known to the public, who would be ready to purchase those oysters ?—That every bed was registered ?

18487. That every bed was registered ?— Yes, certainly.

18488. Then it might be some time afterwards that a bed was found to be unsatisfactory ?—Yes.

18489. In the meantime the consumption of oysters which are not fit for consumption might be going on ?—Yes, I suppose some administrative arrangement could be made by which if they were found very bad on examination, they could be summarily stopped. That is a matter of administrative detail that I hardly have the experience to speak upon.

18490. Then you would only register the beds which were satisfactory and leave the others unregistered ?—I should have thought—but I have no experience—it would have been better to register the whole lot just in the same way as you register dairies and cowsheds. They all have to be registered, whether good or bad, and you take proceedings afterwards if they are unsatisfactory. The registration would not imply that they were good.

18491. (*Sir Wm. Ramsay.*) Have you any other remarks that you would like to make ?—No, sir.

TABLE handed in by Dr. *Savage.*

Bacteriological Analyses of some Sea-water samples.

Source of Sample.	Number of Organisms developing.		Presence of B. Coli.	Presence of B. Enteritidis Sporogenes.
	At 37° C.	At 22° C.		
1. Sea water. Over "perches" Mumbles oysters.	15	140	In $\frac{1}{10}$, $\frac{1}{2}$ c.c., &c. - -	Nil in 5 c.c.
2. Sea water. Over "plantations," Mumbles oysters.	16	165	In $\frac{1}{10}$, $\frac{1}{2}$ c.c., &c. -	Nil in 5 c.c.
3. Sea water, Swansea Bay. Over Bay oysters.	26	148	Not in $\frac{1}{10}$ or $\frac{1}{2}$. In 2, 10, 40 c.c.	——
4. Sea water, 4 miles out. Over white oyster beds.	6	210	In 40. Not in $\frac{1}{10}$, $\frac{1}{2}$, 2, 10 c.c,	——
5. Sea water. Off Penarth beach - -	850	1,440	In $\frac{1}{10}$, $\frac{1}{2}$ c.c., &c. Not in $\frac{1}{30}$ c.c.	In 5 and 10 c.c. Not in 1 c.c.
6. Sea water, mid-channel. Off Flat Holm Island. (17 Jan. 1903.)	256	2,130	Not in 10 c.c. or less -	In 10 c.c., but not in 1 c.c.
7. Sea water, mid-channel. Off Flat Holm Island. (29 Jan. 1903.)	340	730	In $\frac{1}{10}$ and $\frac{1}{2}$ c.c. - -	Not in 1 or 5 c.c. 20 (?) doubtful. 50 and 10 c.c. +
8. Sea water, quarter mile beyond Penarth Pier.	720	3,860	In 10 and 40 c.c. Not in less.	Not in 1 c.c. In two out of three 5 c.c. tubes.
9. Sea water. At Penclawdd (cockles area). (Said to be no possibility of sewage contamination).	- - Spoilt - -		In 10 and 40 c.c. Not in $\frac{1}{2}$, 2, 10 c.c.	——

SIXTY-SECOND DAY.

Tuesday, 14*th July*, 1903.

PRESENT :

The Right Honourable The Earl of IDDESLEIGH (*Chairman*), presiding.

Sir WILLIAM RAMSAY, K.C.B., F.R.S.	Colonel T. W. HARDING, J.P.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.	Mr. T. J. STAFFORD, F.R.C.S.I.
Mr. W. H. POWER, C.B., F.R.S.	

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT :

Dr. H. T. BULSTRODE.

Mr. MAURICE FITZMAURICE, C.M.G., called; and Examined.

Mr. M. Fitzmaurice, C.M.G.

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18492. (*Chairman.*) You are Mr. Fitzmaurice, the Chief Engineer of the London County Council?—Yes.

18493. Can you say how long you have been acquainted with the London drainage system?—I have been acquainted with it more or less since 1892, because at that time I had charge of the Blackwall Tunnel, and there were many main sewers constructed in connection with that work.

18494. Can you give us a history of the London County Council drainage system?—For the purpose of making the matter quite clear, it is necessary to refer shortly to the arrangements made for dealing with London main drainage before the present system came into operation.

The system in operation in 1854 consisted of main sewers, which followed generally the valley lines approximately at right angles to the river and discharged into the Thames, but at about mean tide level the rising tide closed the outlets and dammed back the sewage, which accumulated in the main portions of the sewers, and remained stagnant for several hours daily.

In 1856 the Metropolitan Board of Works instructed their engineer, the late Sir Joseph Bazalgette, to prepare plans completely revising the main drainage. The system adopted was that of building large intercepting sewers on each side of the river, running roughly parallel to the river, into which all the sewage from those sewers which originally ran into the river was taken and carried by these main intercepting sewers to Barking on the north side and Crossness on the south side.

Dealing first with the north side of the river, there are three intercepting sewers, the northern, middle, and low level; the sewage from the two former runs to Barking by gravitation, while that in the last-named sewer has to be pumped at two places, the Western pumping station and the Abbey Mills pumping station; it then runs from this latter station to Barking by gravitation.

On the south side of the river there are two main intercepting sewers, the high level and the low level; the former running by gravitation to Crossness, the latter having to be pumped at Deptford. All the sewage has to be pumped at Crossness.

These sewers are, of course, not capable of carrying off very excessive rainfall; in fact, they become surcharged if the rainfall exceeds more than about a quarter of an inch in 24 hours. On this account certain storm overflows have been provided, so that when the sewers become surcharged the rain water can flow by these overflows directly into the river. Should there be a heavy rainfall at the same time as high tide in the river, the outlet of these storm overflows is naturally closed by the water in the river. This has been the means of causing considerable flooding in several low-lying districts. To reduce this flooding as much as possible, the London County Council has provided pumping stations at the outlet of some of the storm relief sewers, so as to pump the rain water into the river when owing to high tide it cannot flow in by gravitation.

When the sewage reaches the outfalls at Barking and Crossness, four grains of lime and one grain of protosulphate of iron are added to each gallon of sewage, so as to precipitate the matters in suspension.

As the sewage enters the outfall works, there are, on an average, at Barking, 33 grains of suspended matter per gallon of sewage; the effluent contains only 8 grains of suspended matter. Taking the difference between the two, although this cannot be absolutely accurate, we have 25 grains per gallon of suspended matter left in the precipitation channels.

The proportion of suspended matter and the amount precipitated is slightly different at Crossness.

The effluent is discharged into the river at Barking and Crossness, and it amounted during the year 1902 to a daily average of 232 million gallons.

The sludge left in the precipitation channels, 92 per cent. of which is water, is pumped into steamers which carry it away to the Barrow Deep, and it is there discharged over a length of from 5 to 10 miles.

There are six steamers for dealing with this sludge; each is capable of carrying about 1,000 tons, and they make, on an average, 10½ trips per week per steamer. One steamer is generally laid up for repairs.

The Barrow Deep is practically the open sea, being situated about 20 miles below Southend, and is not used for general navigation. By arrangement with the Trinity House no cargoes are discharged westward of an imaginary line drawn from the Maplin lightship to No. 10 buoy, which is about 5 miles eastward of the Mouse lightship. The ships carrying the sludge report to the Mouse lightship each time they pass both out and home. For this purpose each ship has a signal letter allotted to her, and hoists the letter flag by day, and the Morse signal letter is flashed during hours of darkness. The time of passing the Mouse is noted, and the reports from the lightship are compared with reports sent by the London County Council to the Thames Conservancy. Information is also sent to the Thames Conservancy of the number of times each vessel is loaded at the outfall works.

The distance from the Barking outfall to No. 10 buoy is about 48½ miles, and if the vessel steams 9½ miles while discharging the sludge, the total distance would be 58 miles, making 116 miles for the run out and home.

The maximum tide is at Gravesend Narrows, where at times it exceeds 4 knots an hour.

As far as possible it is arranged that the sludge shall be discharged on the ebb tide. The present fleet of six steamers would be unable to deal with the sewage unless they took advantage of going down on the ebb tide and coming back with the flood.

It has been suggested that the sludge should be carried a certain distance further to sea than is at present done. There is, of course, no impossibility in doing this, but it would mean a very large increase in the fleet, as the ships would have to run independently of whether it was flood or ebb.

He has made inquiries as regards the set of the current from the Barrow Deep on the flood tide, and from the information obtained it does not appear to set towards the Maplin sands, but rather straight east and west, with possibly a slight tendency towards the Medway.

The total amount of sludge sent to sea during the year 1902 was 2,607,000 tons, making a weekly average of 50,134 tons.

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The cost of conveying the sludge to sea amounted to 2·76 pence per ton for the year 1902. The cost of the six sludge steamers was £145,697.

18495. May I ask if you consider, generally speaking, that the existing state of things is now satisfactory?—Is that with reference to the effluent, or with the disposal of sludge, or generally?

18496. Generally?—Well, I think it will be better if you will allow me to amplify my answer on that. The County Council are at the present time constructing two new main sewers on the north side of the river, and one new main sewer on the south side, and when these sewers are in operation a great deal more sewage will come to Barking and Crossness than at the present time. That is due to the fact that at the present time, if there is more than about one-quarter of an inch of rainfall in 24 hours, the sewers get surcharged, and a large amount of rainfall, with possibly a certain amount of sewage, is discharged into the river at certain points along the river so as to relieve the sewers themselves. There is considerable difficulty in relieving the sewers if high water occurs at the same time as a heavy rainfall, because the flaps on the sewers are then closed by the tide, but to obviate this the Council are putting up pumping stations. They have got one at Heathwall on the south side of the river, and they have now just constructed one, which will be in working order in a few weeks, at Lots Road, in Chelsea, and there are others at North Woolwich and the Isle of Dogs. At all these stations when high water occurs at the same time as a heavy rainfall, the water from the sewers is pumped into the river, as otherwise of course it would flood the low lying districts.

18497. That is, the construction of these new sewers is principally to deal with the storm water?—To a great extent it is not satisfactory to discharge a large amount of storm water into the Thames.

18498. (*Mr. Power.*) Will the new sewers take the storm water to the outfall, or will they discharge it into the Thames between bridges?—No, they will take it to the outfall at Barking and Crossness.

18499. Will that mean pumping of all that sewage? Will it be a low level sewer?—Oh, no. Perhaps I ought to explain there are three main sewers on the north side of the Thames; two of these carry the sewage by gravitation to Barking, and the sewage in the low level sewer which goes along close to the river has to be pumped at two places, at the western pumping station near Chelsea, and also at Abbey Mills, so that it is only from one sewer that the sewage has to be pumped.

18500. But the new sewers, will they require to be discharged by pumping?—In the case of the new sewers, it may have to be pumped in one, but certainly the second one will be carried by gravitation.

18501. Then you pump from the lower sewers into one or other of the higher sewers at the pumping station?—We pump into the same sewer at a higher level; a continuation of the same sewer.

18502. (*Chairman.*) What proportion of the whole sewage in London is actually taken out in your vessels and discharged into the ocean?—Well, the best thing would be for me to give you the exact figures for each day. About 230,000,000 gallons of sewage is the ordinary dry weather flow. Then the more solid matters, matters in suspension, are precipitated from that sewage, and about 7,000 tons of that sewage are sent in sludge vessels to the Barrow Deeps.

18503. About 7,000 tons?—About 7,000 tons, yes.

18504. And that represents what sort of proportion?—If you will just allow me to work it out.

18505. Yes?—It is not 1 per cent.

18506. Not 1 per cent.?—No; but, of course, that 1 per cent. includes all the solid matter from the sewage; it is the worst part of the sewage.

18507. But still it is only a comparatively small part of the sewage?—Oh, quite so, yes. The idea of the thing is to concentrate the worst part of the sewage as much as possible, then all that concentrated part is sent out to the Barrow Deep.

18508. How do you concentrate the sewage?—I think I had better perhaps explain what we do at Barking.

18509. Yes?—The sewage comes to Barking by three main sewers, and at a certain distance above Barking four grains of lime are added to the sewage per gallon, and one grain of proto-sulphate of iron. The sewage then goes into long channels about 30ft. wide and about 500 or 600ft. long. These chemicals cause the precipitation of nearly all the matters in suspension in the sewage. These matters are left in the precipitation channels.

18510. In the precipitation tanks?—In these precipitation tanks, yes. All this solid matter that is left in the tank is swept down, or a certain amount of it flows down, to pumps at a lower level. Well, it is first allowed to settle for some time, and then the further thin liquor that forms on the top is pumped off, and is sent back to be treated with chemicals a second time, but the heavier part underneath is pumped into the sludge vessels. Of that heavier part, about 92 per cent., is water.

18511. Then you send the latter part back to be chemically treated a second time?—The former part, the thin liquor which forms on top, is treated a second time with chemicals, but the latter part, the sludge, is pumped into the sludge steamers.

18512. About the storm water question, how much is the dilution when the storm overflow comes into action?—Well, the sewers at the present time can carry off about a quarter of an inch of rain in 24 hours; anything beyond that is discharged into the river.

18513. And do you know the amount of the dilution that there would be in the quarter of an inch of rainfall in 24 hours?—It depends altogether on the amount of the rainfall. If the rainfall is only a small amount in excess of the amount the sewers can carry off, the dilution may not be very great, but if the rainfall is a very heavy rainfall, such as we had quite recently, of course the dilution is enormous.

18514. But storm overflows come into work if there is more than a quarter of an inch of rainfall; is that it?—That is so, yes.

18515. And a quarter of an inch of rain would cause what extent of dilution?—I really could not tell you that.

18516. (*Major-General Carey.*) How many times per annum on an average are the sewers surcharged, and the storm overflows come into operation?—I should think, judging from the number of times we pump the sewage at high water, or rather the stormwater, about, perhaps, 60 hours in the year.

18517. May that mean 60 different days?—Oh, no; it would mean that they were running for three or four hours on one day, and then they might not run for a month.

(*Mr. Power.*) That is three or four hours pumping on one tide.

18518. (*Major-General Carey.*) Have you got any record?—Yes, I can put in the records at the different places, if you wish.

18519. (*Mr. Power.*) What did you say you reckon the dry weather flow to be?—230,000,000 gallons.

18520. That is what is discharged as effluent at Barking?—Yes, that is the dry weather flow at Barking and Crossness.

18521. That includes whatever rainfall gets into the sewers and any water that the sewers pick up; the sewage is not estimated on the water supply or anything of that kind; it is what actually comes down to the works?—That is so; but that 230,000,000 gallons does not include any rainfall, but it is what is called the dry weather flow with no rainfall.

18522. Practically with no rainfall?—With no rainfall.

18523. In wet weather you get much larger amounts?—Oh, yes; much larger.

18524. How much larger?—At the Barking outfall alone we have had 300,000,000 gallons.

18525. That compares with some 140,000,000 gallons ordinarily delivered at Barking; the 230,000,000 gallons includes both Barking and Crossness, does it not?—That is both Barking and Crossness.

18527. And the 300,000,000 would that include both again?—No, the 300,000,000 is Barking only.

18527. (*Colonel Harding.*) Perhaps Mr. Power would ask Crossness also, and then we could get at the amount dealt with in rain time?—I am not sure that I can divide up that 230,000,000 gallons for the moment, but I can get those figures exactly for you.

18528. Would it be double 230,000,000 gallons when you are carrying off the rainfall that your present sewer

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can bring to these works, would it be double 230,000,000 gallons?—Oh yes, I think it would.

18529. Just about?—Yes.

18530. Should we be right in taking it that you are able to deal with one dilution?—Yes, I think that would be the case.

18531. About?—Yes.

18532. (*Mr. Power.*) At Barking?—At Barking and Crossness, taking them together.

18533. Is the effluent discharged at all states of the tide at Barking?—Yes.

18534. You say that you have made some inquiries as regards the set of the current from Barrow Deep on the flood tide, and that the tide appears not to set towards the Maplin Sands, but rather straight east and west, with possibly a slight tendency towards the Medway?—Yes.

18535. Have you made any observation of the set of the first of the following ebb, as to the direction in which that goes?—No, I think not.

18536. As to whether it comes down we will say, towards Whitstable or whether it goes out again directly east?—No; I have not made observations, and I should like to say that those observations that I mention are not float experiments.

18537. They are not float experiments?—No. I want to make that quite clear. We have not made any float experiments there, I have simply made inquiries. I have asked the masters of our sludge vessels, who, of course, are there every day, and can judge fairly well, and that is what they have told me. I think it might be useful to have float experiments there.

18538. Would you just demonstrate on the map the course of the sludge vessels out and home? I think it would be convenient for the Commission?—There is the Barking and Crossness Works, and the vessels simply come down the river, and then wait until they pass No. 10 buoy here before they begin to discharge any sludge.

18539. At what state of the tide do they start from Crossness?—They start any time between two hours before high water and perhaps an hour afterwards. We try as far as possible to get them to start before high water.

18540. And then they get down to No. 10 buoy at about what state of the tide?—They get down to No. 10 buoy before the flood begins to run. I should like to qualify that. It has happened that the last steamer of the five coming down—we generally have five running—may not come down until practically low water.

18541. And then they steam along the western edge of the Barrow Deep, and come out along the eastern?—They steam along from No. 10 buoy to No. 1 buoy.

18542. And then come back along the edge of the other sand?—And come back the Barrow Deep.

18543. They do not go into Black Deep at all, do they?—No.

1544. They are discharging sludge during the whole of the journey from No. 10 buoy, until they get back to it, practically; is it very gradual the discharge of the sludge?—It is, yes; the orders of the captains are to discharge it over a length of 10 miles. Each vessel contains about 1,000 tons of sludge, and I think those orders are fairly carried out.

18545. At any rate, they have to go as far as No. 1 buoy before they turn back, do they?—Yes. We keep particulars of what each vessel actually does. You perhaps would just like to look at these returns. They show the time of passing the Mouse Lightship and turning round No. 1 buoy.

18546. The master of the vessel keeps this?—That is sent up to me every day, and, it will be seen, the time the vessel passes the Mouse Lightship is here noted, and forwarded to the Thames Conservancy.

18547. He is checked at the Mouse Lightship?—He is checked at the Mouse Lightship.

18548. Checked by observations on the lightship?—That is so, yes.

18549. (*Chairman.*) Did I understand you to say that the state of the current from the Barrow Deep has not been ascertained by experiment?—Not so far as I know. I myself have made no experiments with floats, which, of course, is the most satisfactory way of doing it.

18550. Have you ever thought of making any experiments?—Well, I have thought about it, but we really have not been able to get any done before now, but I think it would be very useful to make such experiments.

18551. It would be very interesting I think?—I am sure if the Commission expressed a wish to have it done we could arrange to have it done.

18552. I think there is no doubt about it.

(*Major-General Carey.*) It would be most desirable.

(*See memorandum at end of Mr. Fitmaurice's evidence.*)

18553. (*Mr. Power.*) But the information as to currents is from the light vessels, for instance, from the Mouse and the Nore, is it not?—From the masters of our own sludge vessels.

18554. Of your own vessels?—From our own vessels, yes.

18555. (*Major-General Carey.*) Is there any tendency to silt up in the Barrow Deep in consequence of the deposits?—I do not think so.

18556. Have any experiments been made?—Some experiments were made some years ago, before I was with the London County Council, and, as far as I remember, the tendency to silt up was quite inappreciable.

18557. How do you account for the absence of any silting up?—Is the sludge carried in one direction or another through the deep?—It is; I suppose a good deal of the sludge is carried out to sea, and, I am told, a good deal of it is eaten by fishes, but I really cannot tell you very much about it. I can easily get hold of the experiments that were made, and put them in if you wish.

18558. (*Mr. Power.*) What is the depth of water in Barrow Deep at low water; do you know how many fathoms?—I have not got it on my mind, but it is marked on the chart.

18559. (*Major-General Carey.*) There is no dredging of the deep?—Oh no.

18560. Simply the sludge takes its chance?—Yes, it is very deep, indeed.

18561. (*Mr. Power.*) It is deep water?—It is very deep.

18562. (*Colonel Harding.*) It might be well to get on the evidence the depth of the Barrow Deeps?—Thirteen fathoms seems to be about the deepest, and then it seems to vary between 10 and 12.

18563. (*Major-General Carey.*) Does that vary at all from year to year?—I think not.

18564. You say it is on that particular date of the chart?—I think it remains fairly constant; I think there is very little variation of depth there.

18565. (*Mr. Power.*) What is the width of the channel from sand to sand?—You mean the Barrow Deep Channel.

18566. Yes, the Barrow Deep?—It is almost exactly a mile. That is the narrowest place.

18567. (*Major-General Carey.*) A mile between the buoys?—It is a mile at this point here—(*indicating*).

(*See chart following page* 130.)

18568. Is that the scale on which the map is drawn? The scale shows more than that, does it not?—I am taking it off the chart here.

18569. It is two miles?—It certainly looks more than that.

18570. (*Mr. Power.*) It is 10 miles in length, the Barrow Deep?—Yes. I think the explanation is that I am taking from inside the nearest part of the sand, and on the cartoon they have put on the more central part on each side. It is not quite the same extent shown here; then there they have put on the yellow part the similar portions, and I have taken this width here (*indicating*)

18571. (*Major-General Carey.*) Is all the sewage at Barking treated in the precipitation tanks during a storm?—Yes, it is; it all goes through the precipitation tanks.

18572. Under all conditions?—Under all conditions.

18573. It passes through the precipitation tanks?—It cannot get into the river in any other way.

18574. Are there any bacteriological records of the effluent above and below the outfall?—I think the chemist will be able to give you all particulars of that.

18575. Have any float experiments been taken at Barking below the outfall to ascertain the course of the effluent?—I believe some were made several years ago.

18576. Was that during the last Commission in 1885?—I think it must have been long before I came to the Council. The only ones that I have seen myself are with reference to finding out if any of the effluent went up the Barking Creek. There is a creek going up here (*indicating on map*), and, in addition, float experiments have been made as regards sewage discharged at Thames Haven. It was at one time thought that it might be advisable to bring all the sewage down to Thames Haven, and float experiments were made at that point, the result of which was that the floats never came back to Thames Haven once they were started from there.

18577. That is not existing now?—No, it is not. I only mentioned that as to what float experiments were made.

18578. There is no record showing that the effluent from Barking is not carried back at flood tide, that it goes a certain distance down and is carried back again?—No. I have not got any float experiments there. There is no doubt that a certai namount of effluent must be carried past Barking on the flood tide. I do not think there can be any doubt about that.

18579. How do you determine the proportion of chemicals to be added to the sewage in precipitation; is the sewage gauged on different days?—Yes, we know exactly the amount flowing through the different sewers, and the lime and iron are mixed with water, and the proportion added. It is done carefully.

18580. Do you vary the proportions?—Certainly.

18581. According to the volume coming down?—Oh, yes.

18582. Is there a gauge on the pumps?—There is a gauge on the sewers.

18583. (*Mr. Power.*) You say it has been suggested that the sludge should be carried a certain distance further out to sea than at present. Where was it proposed that it should be taken?—It was suggested that it would be a great improvement to carry it 10 miles beyond No. 1 buoy.

18584. Before they commence to discharge it?—Before they commenced to discharge it, yes.

18585. But, as before, through Barrow Deep?—Through Barrow Deep, yes.

18586. (*Major-General Carey.*) Why was that proposal made—because they were afraid of the sewage coming back?—I suppose that was the idea. It seems natural the further away you carry it, the less chance there is of its coming back on the Maplin Sands.

18587. They did not go on any actual information by float experiments?—No.

18588. (*Colonel Harding.*) You have knowledge doubtless as to the amount of trade effluents in the London sewers, have you not?—We are very fortunate; we have practically no trade effluents; we consider it altogether domestic sewage. We have not got the difficulties which exist in the Midland towns at all. The trade effluent is so small in comparison to the total amount of the sewage that it practically need not be considered.

18589. There are, of course, considerable volumes of trade effluents turned into your sewers, but relatively to the vast volume of domestic sewage you say it is practically unappreciable?—That is so.

18590. But you have breweries, for instance?—There are, yes.

18591. Fellmongeries also; there must be a good deal of tanning?—In the Bermondsey district there is some tanning, yes.

18592. Has it ever been estimated by your Council what is the relative volume of trade effluents to domestic sewage?—I do not think it has at all.

18593. Would you be good enough to tell me what is the policy of your Council with regard to the reception of trade effluents into sewers?—Well, under the Metropolis Management Act, I think it is, we have power to prevent anything coming into the sewer which will either harm the sewer or harm the men who work in it.

18594. Yes, the general powers applicable to the whole country?—Yes.

18595. But what is the policy of your Council; do you, as a rule, receive trade effluents?—If it does not damage the sewer or is not dangerous to the men working.

18596. As a fact, have any applications been made to you to receive trade effluents which do damage to the sewers or which lead you to refuse them?—We have had several prosecutions of firms, but principally on account of turning in hot condensing water, but we have had a large amount of trade effluent, I may call it, turned in in the north-east of London. There is near the sewer called the Hackney Wick sewer a great number of manufactures dealing with cleaning works, cleaning clothes and things of that kind, and a very dangerous effluent has sometimes been turned into sewers in that neighbourhood. In fact, we have had several explosions in sewers there on that account, and at the present time we are making a new sewer in that district, and I am just arranging to start during the next few months to make intercepting chambers outside manufactories from which we think any dangerous sort of trade effluent is coming into the sewer, so as to know exactly what firms are sending in this effluent. It is very difficult to find out.

18597. I gather these intercepting tanks are made at the expense of the Council?—They are, yes.

18598. On the Council's own premises?—They are made outside the premises of the manufacturer.

18599. In the street?—Under the footpath.

18600. You do not call on the manufacturer to put in this intercepting tank?—No, I do not think we have got power to do that. Once we can find out or prove that they are sending in any dangerous effluent, we can make them stop it.

18601. May I take it that the occasions when you have to stop the turning of an effluent into your sewers because of its peculiar dangers are comparatively rare?—They are, yes.

18602. And, speaking generally, you receive trade effluents?—We do, I think, speaking generally.

18603. Do you think your Council has any views as to the necessity of making a charge in connection with the treatment of trade effluents?—I do not think they have ever considered that question at all. The trade effluents I am referring to are, of course, principally petroleum spirit.

18604. Yes, those one can conceive to be possibly very dangerous, but apart from those dangerous trade effluents, there must be a great many small trade effluents going into your sewers, and you do in fact receive them?—We do receive them.

18605. And you make no difficulty about it?—No.

18606. In all probability a connection is made without your knowledge?—I do not think any connection is made to our sewer without our knowledge.

18607-8. Then knowing that the connections are about to be made you allow them?—We do, yes. In some cases there might be a connection made to a local sewer which would continue into our sewer, and that is one of the cases where we find considerable difficulty in tracing where hot water comes from. We have had a great deal of trouble, for instance, with a distillery which is sending in a large quantity of hot water, and it is very often difficult to find out where the hot water comes from. I might give another instance of that. Perhaps some members of the Commission have noticed a ventilator right in the middle of Oxford Circus. During the winter you very often see steam coming up that ventilator right in the middle of the circus, and up to the present time I have found it absolutely impossible to find where that steam is coming from.

18609-10. The point you raise is rather an interesting one. It applies, I think, to all the great cities. There are a multitude of little steam boilers, and these are emptied almost invariably into the sewers?—Yes.

18611. And emptied at a very considerable heat?—Yes.

18612. Well, what is the inconvenience that you notice in connection with the turning into your sewers of hot water, water quite unpolluted, but at considerable temperature?—There are two inconveniences which arise; first, it may be extremely dangerous to our men working in the sewers to have a large amount of hot water coming down upon them. We have had men actually at work in the sewers scalded very severely. The other point is, that the hot water may have a very serious effect on certain substances in the sewers, and may cause certain chemical changes which would not otherwise happen, and might be dangerous to the sewers.

18613. Have you noticed any actual damage to the sewers themselves?—I should not like to say that I have noticed very much, but we have to continually put in new inverts to the sewers. Of course, that is principally due to sand and gravel going along the sewers, but

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there is no doubt that certainly the deterioration of the invert is hastened by large quantities of hot water coming down.

18614. Would it not be comparatively easy to call upon the manufacturer turning out this hot water to have on his own premises an intermediate tank or sunk shaft into which it should be discharged, and by such discharge the temperature reduced?—I think it would be a very excellent thing.

18615. It is in fact done by many other towns?—A great amount of this water is used for condensing purposes, and many people use condensing ponds, and cool the water and use it over again.

18616. Now, apart from the damage to the sewers themselves, which I gather is evidently very trifling, apart from the chemical action that might be caused by introducing heat among the matters in the sewers, the bringing of hot water into the sewers would be rather an advantage than otherwise, would it not?—I do not think so.

18617. Is it not a fact that the higher temperature of sewage facilitates the bacterial action where bacterial treatment is going on?—I should not like to answer that question.

18618. You have not gone into that?—But I am quite sure it facilitates our not being able to get our workmen to work in the sewers.

18619. As to the question of cost to the larger City of London of the work which is carried out for such purification, can you give us any data what is the cost at which this work is done by the London County Council? This work is done by the London County Council, is it not?—Altogether, yes.

18620. Then what is the rateable value of the area under the control of the London County Council?—The area is 121 square miles.

18621. What is the rateable value of that area?—I am afraid I would have to get those figures for you.

18622. Do you happen to remember what is the cost in the pound or the cost per head to the people of London?—No, I could not tell you that.

18623. Of such purification?—No.

18624. It would be possible to obtain that from the financial department of your Council?—Yes, we can get all those figures for you.

18625. Could you put that in when you send us the proof of your evidence?—Certainly.

18626. It would be interesting to know what is spent in this great City in connection with sewage purification?—That would be apart from keeping up sewers and pumping, or would you like both?

18627. Simply sewage treatment?—Sewage treatment I think I could almost tell you offhand, but I would perhaps rather keep it until I can give you the exact figure. (*See* Statement at end of evidence.)

18628. In answer to a question by the Chairman as to how far the action which you carry out in sewage was considered by you satisfactory, you limited yourself, I think, to this—that you thought the storm overflows came into action too soon, and that some change with regard to them was about to be carried out, so as to take to Barking and Crossness a larger volume?—That is so.

18629. But you did not go on to say anything as to the effect of the effluent turned out at Barking and Crossness upon the Thames waters?—I really avoided saying anything about that, because Dr. Clowes, the chemist, who will come after me, has made experiments all along the river both up and down, and he will be able to give you full particulars.

18630. Would you prefer that this question should be addressed to him?—Yes.

18631. (*Chairman.*) Could you tell the Commission or give an estimate as to how long a given particle liberated at Barking would take to reach the Nore lightship?—I could not.

18632. Do you think it would get down in the course of a week?—I should not like to guess at it.

18633. You have not read the experiments that were made by the representative of the Commission on the Metropolitan sewage discharge?—I have read them, but I have not got them in my mind.

18634. You know that they found when floats were put in at Barking that the floats on the spring tide went up about Putney Bridge?—I did not know they went up as far as Putney Bridge; I was not aware of that.

STATEMENT subsequently forwarded by Mr. MAURICE FITZMAURICE.

(1). Population of main drainage area (1901), 5,136,261.

	£
(2). Ratable value of the County of London (1903) - - - -	40,601,822
Ratable value of certain districts outside the county, the drainage from parts of which flows into the London main drainage system (1903) - -	3,178,450
Total ratable value of main drainage area (1903) - -	43,780,272

(3). Amount of main drainage rate for all purposes (1901-2), 3¼d. in the £1.

	s.	d.
(4). All expenses in connection with main drainage, including repayment of capital and interest thereon, annual maintenance, etc., per head of population (1901-2) - - - - - -	2	1½
(5). Annual cost per head of population for everything in connection with main drainage, exclusive of repayment of capital and interest thereon (1901-2) (Being part of No. 4.)	1	0½
(6). Annual cost of treatment of sewage, including disposal of sludge, etc., per head of population - - - - (Being also part of No. 4.)	—	6

MEMORANDUM on float experiments made at the Barrow Deep on 22nd September to 1st October, 1903.

The experiments were made at the request of the Royal Commission on Sewage Disposal.

Two points were taken in the Barrow Deep, A and B on chart. A is the most westerly point at which the London County Council's sludge vessels begin to discharge their cargo, and B is about the most easterly point at which the sludge is discharged.

In each case floats were started from points A and B at low water, and the course of the floats was noted during the following flow and ebb.

The experiments were made during spring and neap tides, and a diagram showing the range of tides covering the period during which the experiments were made is attached.

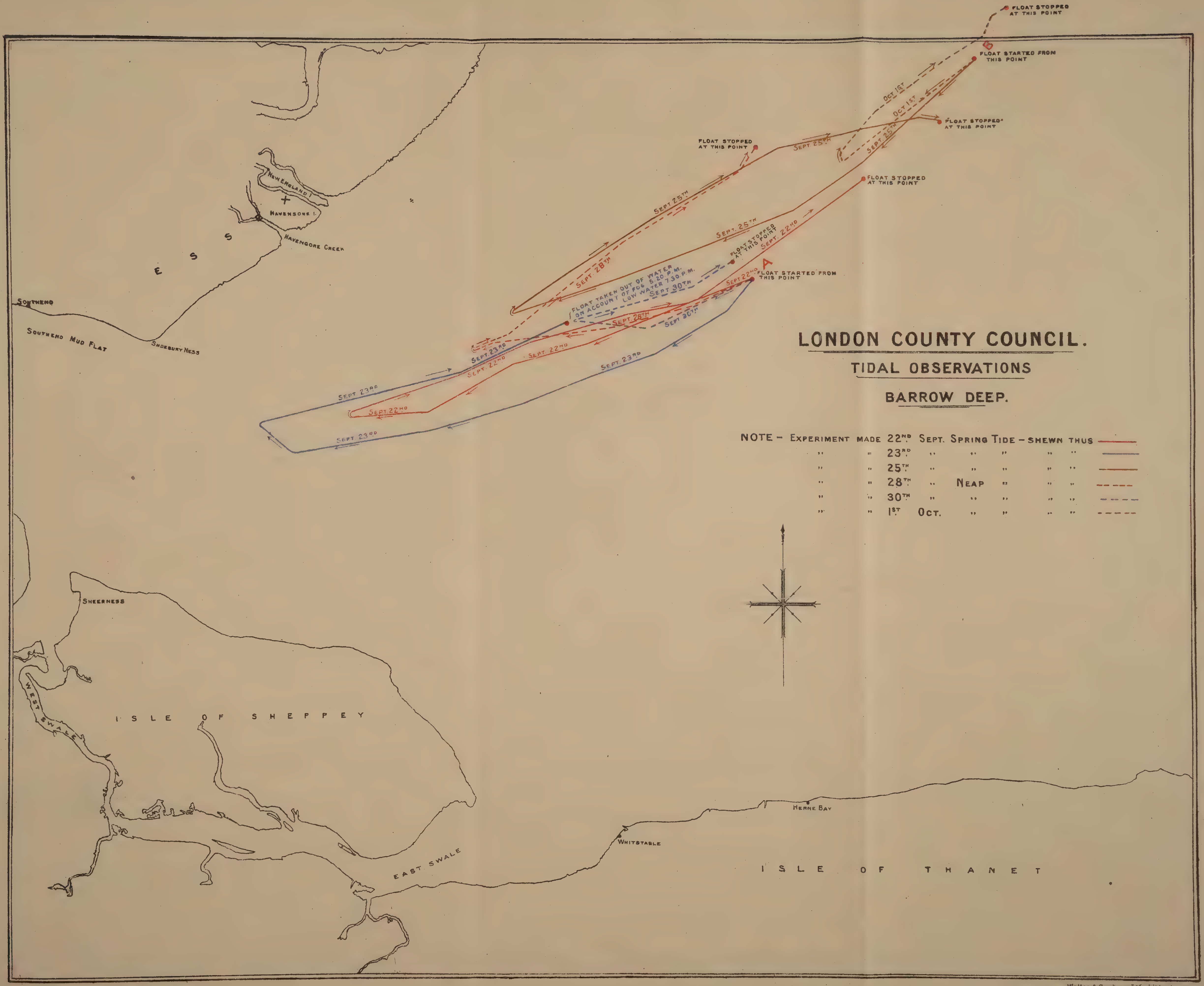
Four floats were started from point A as follows:—

Spring or Neap Tide.	Date.	Colour on Chart.	Remarks.
1. Spring.	1903. 22nd Sept.	Full Red.	Float returned to East of point of starting.
2. Spring.	23rd „	Full Blue.	Float taken out of water on account of fog, but judging by time taken out would have returned to East of point of starting.
3. Neap.	28th Sept.	Dotted Red.	Float returned to East of point of starting.
4. Neap.	30th „	Dotted Blue.	Float returned to about the point of starting.

Two floats were started from point B as follows:—

Spring or Neap Tide.	Date.	Colour on Chart.	Remarks.
1. Spring.	1903. 25th Sept.	Full Brown.	Float did not quite return to the point where started.
2. Neap.	1st Oct.	Dotted Brown.	Float returned to East of point of starting.

MAURICE FITZMAURICE,
Chief Engineer, L.C.C.



LONDON COUNTY COUNCIL.

TIDAL OBSERVATIONS

BARROW DEEP.

NOTE – Experiment made 22nd Sept. Spring Tide – shewn thus
" " 23rd " " " " "
" " 25th " " " " "
" " 28th " Neap " " "
" " 30th " " " " "
" " 1st Oct. " " " "

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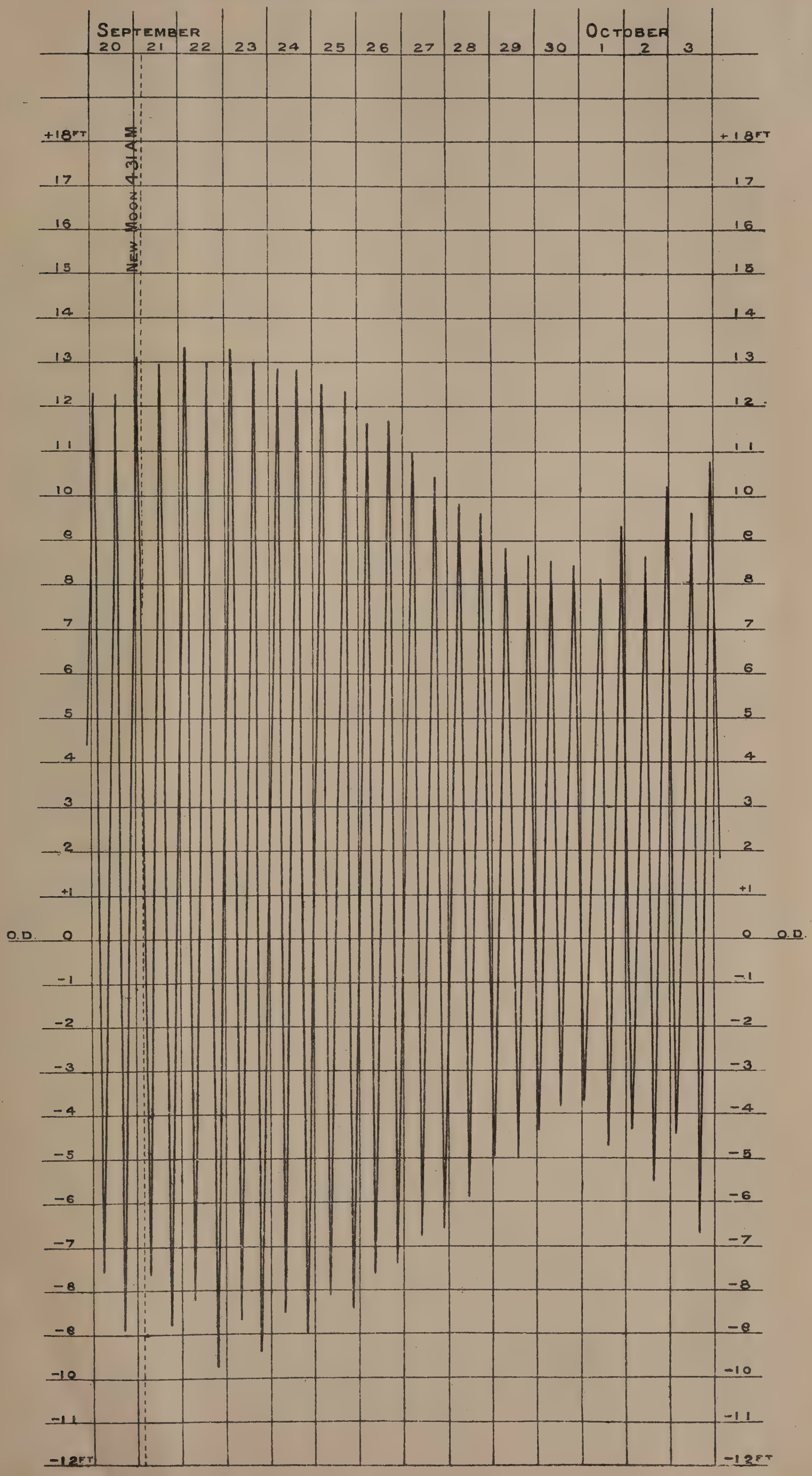
TIDE GAUGINGS 1903 AT CROSNESS.



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Professor Frank Clowes, D.SC. (London), F.I.C., Chemist of the London County Council, called; and Examined.

Professor F. Clowes, D.SC. (London), F.I.C.
——
14 July 1903.

18635. (*Chairman.*) You are Professor Frank Clowes, the Chemist of the London County Council?—I am.

18636. You have prepared for us a very interesting statement of the bacteriological work which you have done, and I would suggest that that comes into the evidence just as it stands?—I agree to this, and would only add that all cultivations were put down at the time of collection of the sample.

ESTIMATION OF THE NUMBER OF BACTERIA IN THE SLUDGE AT THE BARKING OUTFALL.

Between 27th April and 6th May, 1903, estimations of the number of bacteria present in the sewage sludge were made at the Barking Outfall Works. During this period five estimations were made in samples taken from separate cargoes of sludge, and the samples were collected in such a manner as to obtain an average of each cargo.

The results of these estimations are set forth in the following table:—

TABLE A.

Date, 1903.	Total Number of Organisms in one Cubic Centimetre of Sludge.		
	Bacteria which grew at 20° C.	Bacteria which grew at 37° C. (blood heat).	Spores.
29 April -	121,000,000	60,000,000	6,250
2 May -	126,000,000	74,200,000	8,100
4 May -	119,500,000	45,000,000	10,550
5 May -	131,000,000	64,000,000	11,800
6 May -	135,000,000	70,000,000	11,400
Average -	126,500,000	62,640,000	9,620

From the first column in this table it will be seen that the average number of bacteria in one cubic centimetre of sludge exceeded 126,000,000, whilst the maximum and minimum numbers were respectively 135,000,000 and 119,500,000.

The next column contains the results of the estimations of the number of bacteria in one cubic centimetre of sludge after cultivation at blood heat (37° C.). These bacteria when found in sewage polluted water are mainly, if not entirely, of intestinal origin.

In the last column of this table the number of spores found in one cubic centimetre of the sludge is given. The power to form spores is possessed by certain bacteria, and the spore is better able to resist adverse external conditions than the organism itself; it can develop into the organism at any time when its environment favours this change. Accordingly spore-forming bacteria may survive and reappear after passing through adverse conditions which destroy the species which cannot form spores.

BACTERIAL EXAMINATION OF THE WATER OF THE BARROW DEEP DURING AND IMMEDIATELY AFTER THE DISCHARGE OF SLUDGE.

(a) Two series of samples collected at successive points in the Barrow Deep.

Samples for examination were collected at the last of the ebb tide, and in nearly slack water; they were taken every two minutes while the s.s. "Burns" was passing down the whole length of the Deep and back again. The samples from the Barrow Deep were collected between alternate buoys, and were mixed together for the purpose of examination. In this way four samples, two from the south side and two from the north side of the Barrow Deep, were dealt with.

Estimations were made of the total number of bacteria present in one cubic centimetre of the water, and the prevalence of "gas-forming," or intestinal bacteria, was also tested.

The results are set forth in the following table:—

TABLE B.

Date.	Number of Sample.	Time of Collecting Sample.	Locality from which the Sample was collected.	Number of Bacteria per Cubic Centimetre of Water.	"Gas Forming" or Intestinal Bacteria were absent in.
2 April -	1	5.50 - -	Abreast the Nore Light - - -	1,168	Not estimated.
	2	6.25 - -	Abreast the Mouse Light - - -	4,310	1 c.c. of water.
	3	6.50 to 7.20 -	Between Nos. 10 and 6 buoys in the Barrow Deep.	4,500	$\frac{1}{10}$ c.c. of water.
	4	7.20 to 7.45 -	Between Nos. 6 and 2 buoys in the Barrow Deep.	7,450	,, ,,
	5	7.50 to 8.20 -	Between Nos. 1 and 5 buoys in the Barrow Deep.	1,050	,, ,,
	6	8.20 to 8.50 -	Between Nos. 5 and 7 buoys in the Barrow Deep.	1,650	,, ,,
	7	9.20 - -	Abreast the Mouse Light - - -	30	1 c.c. of water.
3 April -	1A	7.30 - -	Abreast the Nore Light - - -	454	Not estimated.
	2A	8 - - -	Abreast the Mouse Light - - -	1,220	1 c.c. of water.
	3A	8.20 to 8.55 -	Between Nos. 10 and 6 buoys - -	500	$\frac{1}{10}$ c.c. of water.
	4A	8.55 to 9.20 -	Between Nos. 6 and 2 buoys - -	4,150	,, ,,
	5A	9.30 to 10 -	Between Nos. 1 and 5 buoys - -	200	,, ,,
	6A	10 to 10.25 -	Between Nos. 5 and 7 buoys - -	400	,, ,,
	7A	10.55 - -	Abreast the Mouse Light - - -	115	1 c.c. of water.

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The examination was made on board the s.s. "Burns" at the time when the Council's sludge vessels were discharging their sludge in the Barrow Deep. The s.s. "Burns" was the last ship on each occasion to discharge her cargo. She closely followed the other ships into the Deep, and an interval of not more than 20 minutes occurred between the passing of any point by the "Burns" and by the vessel immediately preceding her.

In this connection, it may be stated that a short time ago one of the Council's sludge ships was followed at a distance of about a ship's length during the time she was discharging her sludge, by the launch of the Port Sanitary Committee of the City of London, for the purpose of collecting samples at the tail of the sludge steamer.

Samples collected in this manner could not be considered as representative of the so-called polluted water of the Barrow Deep, since they would consist of almost undiluted sludge, and the proportion of sludge to sea-water would be much greater than in samples collected at a reasonable distance from the sludge boat, or in samples of the water which is carried out of the Barrow Deep by the returning tide after the discharge of the sludge. The results of the next series of samples collected and examined by the Council's officers bear out this statement.

(b) Two series of samples collected during six hours at two points at the entrance to the Barrow Deep, and one series collected during two hours in the neighbourhood of the Galloper Light Vessel.

The appended Table C sets forth the results of the examination of these samples.

The two positions at the entrance to the Barrow Deep at which these samples were collected were chosen with a view to the bacterial examination of the water which leaves the Barrow Deep on an inflowing tide after the sludge has been discharged.

On comparing the average number of bacteria per cubic centimetre found in these samples from the Barrow Deep (453) with the average number found in the North Sea in the neighbourhood of the Galloper light vessel (265), it will be seen that the number in the water at the entrance to the Barrow Deep is nearly twice as great as in that found in the open sea. But it must be remembered that the average number of bacteria found in the Barrow Deep, amounting only to 453 per cubic centimetre, is insignificant when compared with the number present in the sludge, which usually amounts to many millions per cubic centimetre; and, further, that the number of bacteria present in the so-called polluted water of the Barrow Deep is frequently found in ordinary drinking water.

ESTIMATION OF INTESTINAL BACTERIA IN THE WATER OF THE ESTUARY.

In addition to the estimations of the number of bacteria present in the water of the estuary, the results are also given of tests made for bacillus coli communis (columns 3 to 8), and bacillus enteritidis sporogenes (column 9).

Bacillus coli communis is an intestinal organism which may be pathogenic. It is almost entirely absent from waters free from suspicion of animal pollution, while in crude sewage, at least 100,000 per cubic centimetre are found. Since, as a general rule, the conditions for its development and increase are not found outside the animal body, its presence, even in relatively small numbers, in water shows recent or continued pollution.

Columns 3 to 8 in Table C refer to the tests for the bacillus coli. In those cases where "no change" is recorded, the bacillus was absent from the quantity of water tested. It will be seen that when one-tenth of a cubic centimetre was used, out of 48 tests only six indicated the presence of bacillus coli. In other words, in only six cases out of 48 was bacillus coli present in larger numbers than 10 per cubic centimetre.

Bacillus enteritidis sporogenes is pathogenic and is of intestinal origin; it is capable of much resistance to unfavourable conditions on account of its being a spore-bearing organism, since spores have far greater resistant power than the organisms themselves.

The test for bacillus enteritidis sporogenes is of value only when a negative result is obtained, since inoculation of a guinea-pig is necessary in order to confirm the result when the test has indicated the presence of the bacillus.

In consequence of the number of the bacillus coli being greater than that of the bacillus enteritidis sporogenes in the water of the estuary, the test for the latter is not so delicate as that for the former, since only one cubic centimetre is used for each test. In other words, since there are about 100 times as many of the bacillus coli in the water as there are of the bacillus enteritidis sporogenes, in order to make the tests equally delicate, if one cubic centimetre of water is used when testing for bacillus coli, 100 cubic centimetres should be used when testing for bacillus enteritidis sporogenes. The use of this latter quantity is, however, impracticable; one cubic centimetre being generally the maximum quantity which can conveniently be used for the tests.

STATEMENT OF CONCLUSIONS.

A study of these tables shows that there are on an average over 100 millions of bacteria per cubic centimetre in the sludge discharged by the Council's steamers in the Barrow Deep, and that about half this number are probably of intestinal origin since they are capable of growing at blood heat (37°C.); but that immediately after the discharge of the sludge the number in the water of the Barrow Deep is less than 2,500 per cubic centimetre, and that the number of intestinal bacteria is generally less than 10 per cubic centimetre; indicating a reduction of about 99·9 per cent. in the total number of bacteria and of intestinal bacteria. Further, that the number of bacteria in the water which is carried out of the Barrow Deep towards the mouth of the Thames by an incoming flood tide, is still further reduced to an average of 440 per cubic centimetre, and that the number of intestinal bacteria has also further decreased.

THE EFFECT OF SEA WATER UPON BACTERIAL LIFE.

The first experiment was made by inoculating separately, 1,000 cubic centimetres of sterilised sea water and 1,000 cubic centimetres of sterilised distilled water with one cubic centimetre of clarified sewage. One cubic centimetre of each of these waters was taken immediately after inoculation and again at stated intervals, and the number of bacteria in the cubic centimetre samples was estimated by cultivating the samples in gelatine medium at 65°F. for a specified number of hours.

The results are set forth in the following table:—

TABLE D.

Date.	Time during which the Water had been Inoculated when the Sample was taken.	Time during which the Samples were cultivated in Gelatine Medium.	Number of Bacteria per Cubic Centimetre.	
			In the Inoculated Sea Water.	In the Inoculated Distilled Water.
1903.				
13 March - -	Immediately - -	72 hours - -	8,748	7,100
16 March - -	3 days - - -	43 hours - -	281,000	288,360
18 March - -	5 days - - -	45 hours - -	531,400	421,200
19 March - -	6 days - - -	48 hours - -	348,000	113,000

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TABLE C.

Date of Sampling and position at which Sample was taken.	Time of Sampling. Except at High and Low Water, the Samples were collected every Five Minutes and mixed together for the Hourly Samples.	Total Number of Bacteria per Cubic Centimetre of Water.	Tests for Bacillus Coli (Intestinal Bacteria). The Cultivations in the following Media were Incubated for 48 hours at 37°C. (Blood Heat). A positive result indicated the presence of Organisms of the Coli Group.						Test for Bacillus Enteritidis Sporogenes in 1 Cubic Centimetre of Water.
			Cultivations made in "Litmus Milk."		Cultivations made in "Neutral Red Broth."		Cultivations made in "Bile Salt Broth."		
			With 1 Cubic Centimetre of Water.	With $\frac{1}{10}$ Cubic Centimetre of Water.	With 1 Cubic Centimetre of Water.	With $\frac{1}{10}$ Cubic Centimetre of Water.	With 1 Cubic Centimetre of Water.	With $\frac{1}{10}$ Cubic Centimetre of Water.	
9th April.—150 yards west of the mid Oaze Buoy.	Low water 4.30 p.m.	304	Acid and clotting produced.	Acid and clotting produced.	Changed to yellow and green.	No change	Acid, microbic growth and gas produced.	No change	Organism absent.
	4.30 p.m. to 5.30 p.m.	251	ditto - ditto	ditto - ditto	ditto - ditto	ditto	No change	ditto	ditto - ditto.
	5.30 p.m. to 6.30 p.m.	347	ditto - ditto	No change	No change	ditto	Acid and growth	ditto	dittt - ditto.
	6.30 p.m. to 7.30 p.m.	677	ditto - ditto	ditto	ditto	ditto	No change	ditto	ditto - ditto.
	7.30 p.m. to 8.30 p.m.	836	ditto - ditto	Slight clotting produced.	Trace of yellow and green.	ditto	ditto	ditto	ditto - ditto.
	8.30 p.m. to 9.30 p.m.	672	ditto - ditto	Acid and clotting produced.	No change	ditto	ditto	ditto	ditto - ditto.
	9.30 p.m. to 10.30 p.m.	519	ditto - ditto	No change	Trace of yellow and green.	ditto	Acid, growth and gas	ditto	ditto - ditto.
	High water 10.30 p.m.	164	ditto - ditto	ditto	No change	ditto	ditto - ditto	ditto	ditto - ditto.
10th April. — Point where line between Nore Light Vessel and West Oaze Buoy crosses line between Cant Buoy and South Shoebury Buoy.	Low water 5.40 p.m	361	ditto - ditto	Acid and clotting produced.	Change to yellow	ditto	Acid and growth	ditto	Organism present.
	5.40 p.m. to 6.40 p.m.	646	ditto - ditto	No change	ditto - ditto	ditto	Lost	ditto	Organism absent.
	6.40 p.m. to 7.40 p.m.	397	ditto - ditto	ditto	Slight yellow and green.	ditto	Acid and growth	ditto	ditto - ditto.
	7.40 p.m. to 8.40 p.m.	381	ditto - ditto	ditto	Change to yellow and green.	ditto	ditto - ditto	ditto	ditto - ditto.
	8.40 p.m. to 9.40 p.m.	697	ditto - ditto	Slight clotting produced.	ditto - ditto	ditto	Acid, growth and gas	ditto	Organism present.
	9.40 p.m. to 10.40 p.m.	315	Acid produced	No change	ditto - ditto	ditto	ditto - ditto	ditto	Organism absent.
	10.40 p.m, to 11.40 p.m,	309	Acid and slight clotting.	ditto	Trace of yellow and green.	ditto	No change	ditto	ditto - ditto.
	High water 11.40 p.m.	373	No change	ditto	No change	ditto	ditto	ditto	ditto - ditto.
11th April.—In the neighbourhood of Galloper Light Vessel.	5.5 a.m. to 5.35 p.m.	215	—	—	—	—	—	—	—
	5.35 a.m. to 6.5 p.m.	191	—	—	—	—	—	—	—
	6.5 a.m. to 6.35 p.m.	357	—	—	—	—	—	—	—
	6.35 a.m. to 7.5 p.m.	298	—	—	—	—	—	—	—

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The inoculated waters and the cultivations in gelatine were both kept at a temperature of 65° Fahr.

Another experiment was made with sea water which had not been inoculated with sewage, and with 750 cubic centimetres of sea water which had been inoculated with one cubic centimetre of clarified sewage.

The processes of sampling and of counting the bacteria in the waters were the same as those adopted in the former experiment, and the results are set forth in the following table:—

TABLE E.

Date.	Time during which the Samples had been standing.	Time during which the Samples were cultivated in the Gelatine Meduim.	Number of Bacteria per Cubic Centimetre.	
			In the Natural Sea Water (not Inoculated).	In the Inoculated Sea Water.
1903.				
27 March - -	Immediately - -	96 hours - -	1,115	11,000
28 March - -	1 day - - -	96 hours - -	94,250	238,000
30 March - -	3 days - - -	96 hours - -	230	1,976.000
1 April - -	5 days - - -	48 hours - -	109	2.373,000

Both the waters and the cultivations in gelatine were kept at a temperature of 65° Fahr.

In each experiment the number of bacteria in the inoculated sea water and in the inoculated distilled water increased up to the fifth day after inoculation, and in the case of one of the sea water samples and of the distilled water, the number had considerably decreased by the sixth day. The two other samples were not counted on the sixth day.

In the case of the natural or uninoculated sea water the number of bacteria increased on the first day, but subsequently decreased until it was reduced on the third day to a number which is not unusually found in ordinary drinking water.

STATEMENT OF CONCLUSION.

The results of these experiments appear to indicate that sea water does not exert any marked inhibitory effect upon the life of bacteria.

EXAMINATION OF THE SANDS IN THE BARROW DEEP AND IN THE THAMES ESTUARY.

A chemical and microscopical examination was made in August, 1899, of the nature of the sea bottom in the part of the estuary where the Council's sludge is deposited, and in parts which might be affected by the sludge.

The results of these examinations of the sands and of the deposits in the Barrow Deep and in other channels in the estuary of the River Thames during the period 2nd to 12th August, 1899, show that no sludge is carried by the tide beyond the limits of the Barrow Deep and the Oaze Deep in a westerly or up-river direction. The sludge which is carried in an easterly or seaward direction must meet with so great a volume of sea water that it is quickly broken up into innocuous bodies, and thus prevented from travelling beyond the Barrow Deep. Accordingly no evidence of pollution by sludge was obtained in an easterly, northerly, or southerly direction.

I should state that the evidence furnished in the above reports is not yet complete; further details will be furnished to the Commission.

18638. (*Mr. Stafford.*) With regard to Table A. relative to bacteria which grow at 20 degrees Centigrade, were these from gelatine cultivations?—These would be gelatine cultivations.

18639. And I suppose the bacteria which grow at 37 degrees Centigrade would be Agar cultivations?—I believe so; they were done by the assistant chemists at the Council's Outfall laboratories, Mr. J. W. H. Biggs at the Southern Outfall, and Mr. E. Brooke Pike at the Northern Outfall.

18640. They are not personally done by you?—They are not done by my own hands, but they are done under my supervision.

18641. And then the third table with regard to the spores, are these the spores of äerobic or anäerobic bacteria?—They are not distinguished here.

18642. No, I see that, but are they?—Well, they would be both, I presume.

18643. Oh, both?—I think so.

18644 (*Sir William Ramsay in the chair.*) Are they grown under äerobic or anäerobic conditions?—These spores were grown under äerobic conditions.

18645. (*Mr. Stafford.*) You do not know the methods employed by your assistants in those cases?—I could give you full details if you wish for them. The assistant chemists have worked according to Dr. Houston's general directions, and these methods have been published in the second report of this Commission. Dr. Houston was associated with us in this work for several years. I think Dr. Houston advises this Commission to a large extent. They are not entered in this report, because this is simply a summary.

18646. I think the Commission would wish to have them. We have had the methods of every bacteriologist, and it is very essential that we should have your methods?—These are Dr. Houston's, and they are published in the reports of our County Council, which we have sent to the Commission.

18647. Perhaps you would let the Commission have them?—We could give you a reference to them; perhaps that would be the simplest way.

18648. Quite so. With regard to the figures in Column 1 again; from the figures in this table it will be seen that the average number of bacteria in one cubic centimetre of sludge exceeded 126,000,000, whilst the maximum and minimum numbers were respectively 135,000,000 and 119,500,000. Can you tell us the amount of dilution which was used in these cases?—The dilution was very large indeed—in some cases, I believe, by a million times. We keep on diluting till we get a number which is countable. We prefer to use a dilution which gives approximately 100 colonies on a plate.

18649. Yes, I think we would like to get these?—Yes.

18650. You then go on to say that these bacteria, when found in sewage-polluted water, are mainly, if not entirely, of intestinal origin. Is not that rather a large statement?—Well, that I make again on Dr. Houston's authority. I do not profess myself to be an expert bacteriologist.

18651. You do not profess to be an expert bacteriologist?—No, I am not; but Dr. Houston's methods of investigation, as I say, are printed in our reports, and those methods have been adopted by my assistants.

18652. Who carries out these methods? Who has actually done this work?—The assistant chemists to the Council, who have been already named.

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18653. Is there a bacteriologist, or more than one bacteriologist, acting under you?—I have a chief chemical assistant at each of the outfalls, Barking and Crossness, and these assistants have done actually the work.

18654. Are they expert bacteriologists?—They are men of very large experience in this work.

18655. (*Chairman.*) Have they worked under Dr. Houston?—They have worked with Dr. Houston for a couple of years, so they know his work and method perfectly well, and he would speak well of their work and methods. We have also two bacteriologists at the central laboratory in Craven Street; these experiments, however, were not done by them. These gentlemen are chemical assistants who have been trained in bacteriology.

18656. (*Mr. Stafford.*) So that we are to understand that we are not to look to you, perhaps, for explanation of some of these statements with regard, for instance, to the number of bacteria in this case which are of intestinal origin?—You must take it, I think, that this statement is made mainly on Dr. Houston's authority.

18657. Can you give a reference to this in any published work of Dr. Houston's?—It is given on page 25 of this Commission's Second Report.

18658. Well, some of the statements in it I should rather like to question perhaps?—Statements of what kind?

18659. With regard to some of the statements here, or rather some conclusions which you draw from them?—I should be very glad to answer them.

18660. If you had been personally responsible for them I would have liked to have had your views about them?—I hold myself entirely responsible for the whole of these statements.

18661. If you have not performed the experiments yourself it would be rather difficult?—It would be impossible for me to do any material part of the work which is done in our laboratories. Our laboratory is a very busy laboratory; it is like the Government laboratory. Where there is a staff of 40 or 50 engaged, of course one has to accept the responsibility of one's staff; it is absolutely impossible to do otherwise.

18662. You go on to say in the last column of this table the number of spores—are they äerobic or anäerobic; they are both, you think?—I repeat that they were grown under äerobic conditions.

18663. In the last column of this table the number of spores found in one cubic centimetre of the sludge is given. The power to form spores is possessed by certain bacteria, and the spore is better able to resist adverse external conditions. Have you any experience yourself of the effect on spores of adverse external conditions?—Yes, the effect of temperature—high and low temperature—and chemical agents; certainly every chemist has made experiments on such subjects. While the organisms themselves perish under such conditions, the spores can withstand conditions which are fatal to the organism.

18664. Have you made any special experiments which may be of use to the Commission, do you think?—Not specially.

18665. About the influences of certain adverse conditions upon the spores?—Yes, I am quite prepared to maintain that the spores can survive conditions which the organism cannot.

18666. Quite so?—That is the general proposition which I would maintain.

18667. But can you tell us the particular conditions which affect them adversely?—Well, I mention the general conditions are conditions of temperature or exposure to certain chemical substances which are adverse generally to the life of bacteria.

18668. But there is nothing particular which you have to observe about the external influences?—No, not beyond that general statement.

18669. You speak later of gas-forming or intestinal bacteria; do you consider that all intestinal bacteria are gas forming, and *vice versâ*?—The intestinal bacteria generally are largely of the gas-forming species.

18670. Yes, but you do not hold that they are all gas-forming; they are not convertible terms, gas-forming and intestinal bacteria?—I take that again on Dr. Houston's authority. This statement is taken from his description of the work. We have classed them according to his classification.

18671. Then in your Table B you speak of the number of bacteria per cubic centimetre of water; are these gelatine 20 degrees Centigrade?—These would be gelatine 20 degrees Centigrade.

18672. And similar Agar at 37 degrees centigrade?—I expect so; that is our usual practice.

18673. And then in the further column gas-forming or intestinal bacteria were absent; can you say what was the medium used in that case?—Gelatine "shake" at 20 degrees centigrade.

18674. But you give general directions?—General directions to work according to the methods prescribed by Dr. Houston. They are printed in detail in our reports; you will find them in his able bacteriological portion of each of our reports. He gives full detailed directions of the methods of work and the results to be drawn. I do not mean to say that we limit ourselves to his information; of course, there are standard textbooks on bacteriology which are also consulted by us, but in this particular series of experiments Dr. Houston's methods were generally adopted, because we wished our results to be comparable with those already furnished by him to the Council.

18675. In your statement you say the number of bacteria present in the so-called polluted water of the Barrow Deep is frequently found in ordinary drinking water; have you any experience of that?—I have very considerable experience of drinking waters. We deal with large numbers of drinking waters, and daily with the whole of the London supply, and have done so for years in the London County Council laboratory, and although 100 colonies per cubic centimetre is the limit proposed by Koch—and is generally accepted—drinking waters frequently transgress that limit, and an average of something like 300 or 400 is well within the quantity which is frequently found.

18676. In drinking water?—Yes, in drinking water.

18677. In town supplies—in the supplies of large towns?—Yes, and in the private well-water supplies for large buildings.

18678. You would not think it a very high standard in the case of a large town, would you?—I think it is an undesirably high number. A part of the London supply is occasionally sterile, or absolutely free from bacteria. That is evidently a desirable state of things, but some water supplies have contained over 1,000.

18679. You would not call it a good drinking water?—I think Koch's standard of 100 is a very good standard.

18680. You go on to estimate in the estimation of intestinal bacteria in the water of the estuary, you say in the addition to the estimations of the number of bacteria present in the water of the estuary, the results are also given of tests made for bacillus coli communis. You give us the information in Table C; did you isolate the microbe in those cases in the pure culture?—Which is that?

18681. You say the results are also given of tests made for bacillus coli communis, did you isolate the microbe in this case?—We did certainly in the case of bacillus coli.

18682. In pure culture?—Yes, separating a particular colony.

18683. Then you applied all tests for communis?—All the tests, yes. I have mentioned specially in the report that in none of these cases could we inoculate. We had no licence for dealing with animals, so that they were simply the ordinary bacterial tests independently of inoculation.

18684. Did you isolate a culture in those cases?—Certainly, in each case.

18685. Because otherwise it would be hardly proper to use the word "communis," I think?—No, it answered to all the tests which are ordinarily recognised as the tests and it was isolated from special colonies.

18686. You go on to say bacillus coli is an intestinal organism which may be pathogenic?—Well, I should explain that this statement was inserted for the informa-

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tion of my Committee, and is taken from Dr. Houston's statement in the Commission's report. This is really a Committee report by permission passed on to you, and that information I do not think I should have put into the Royal Commission exactly, but it was inserted for the information of my Council.

18687. Yes, but do you wish the statement to remain that you put that bacillus coli is an intestinal organism which may be pathogenic? Have you any personal experience upon the subject?—No, I state that wherever this information is given it is taken from the statement already printed in reports of this Commission.

18688. Whose reports are those?—Dr. Houston's.

18689. This information is simply passed on by you from his work. Is he working then for the County Council?—He is not now, but he was retained for two years to work with me on the experimental bacterial treatment of the London sewage, and he and I conjointly published reports at considerable length, my own part being the chemical part, and he supplementing this with considerable bacteriological information, including a detailed account of his methods of work. We are now bringing out our methods in a book which is to be published by the Council for public information.

18690. I was going to ask you whether you have any personal experience of these methods, so that you might tell the Commission about them, but I understand from your reply you are merely quoting Dr. Houston?—These rest on Dr. Houston's authority. The manipulation was carried out by the assistants already referred to, who have had very large experience, for six or seven years, by working with Dr. Houston and subsequently by themselves.

18691. So that I suppose you would probably give a similar answer to the statement that the bacillus enteritidis sporogenes is pathogenic and of intestinal origin?—Well, I do not press that these should be inserted in your information. I think they are general text-book information, or they will be very shortly if they are not already published. It was inserted rather for the Committee, some of whom did not understand bacterial matters, to furnish a little information as to the special nature of the bacillus coli and the bacillus enteritidis sporogenes. These organisms were selected by Dr. Houston, and are generally adopted.

18692. Further on, you say in consequence of the number of the bacillus coli being greater than that of the bacillus senteritidis sporogenes in the water of the estuary, the test for the latter is not so delicate as that of the former, since only one cubic centimetre is used for each test. In other words you compute there are about 100 times as many of the bacillus coli in the water as there are of the bacillus enteritidis sporogenes. How is this ratio established—the 100?—That is simply a result obtained by our experiments, and is not a constant ratio.

18693. It must have been a long process, then, to arrive at?—It is a troublesome process. One has to keep diluting down until the appearance of the bacillus in the dilution ceases.

18694. It is according to Dr. Houston's method that it has been arrived at?—Yes. It is the regular method by diluting down and down, until the bacillus has disappeared in the dilution; it has always been our method of working, and it means sometimes putting down seven or eight cultivations differently diluted.

18695. You also say the first experiment was made by inoculating separately 1,000 cubic centimetres of sterilised sea water. Would not the sterilisation of the sea water alter the composition of it chemically?—I think not, because we found that bacteria freely grow in it after it has been sterilised.

18696. Have you made any experiments on unsterilised sea water?—I do not know that there are any made by the direct addition of a known number of bacteria, still it is always assumed that this sterilising process does not prevent the medium from allowing the subsequent growth of bacteria.

18697. That could only be checked by also working with unsterilised sea water?—I do not think myself that the sterilisation would affect the power of the medium for nourishing these bacteria.

18698. Then you say the results of these experiments appear to indicate that sea water does not produce any inhibitory effect upon the life of bacteria? Is that true, do you think, of the bacillus coli?—Well, no special account was taken of bacillus coli; the total number of bacteria only were counted. We have not gone into detail with separate species of bacteria.

18699. It is a general statement?—It is a general statement with regard to all bacteria present in the sludge, which, of course, would include the coli.

18700. It is conceivable that coli immersed in sea water for seven or ten days would disappear altogether?—As this is not a complete inquiry, I cannot answer that question. All the bacteria including coli were counted. It was not a special inquiry as to species of bacteria.

18701. (*Colonel Harding.*) The very interesting tables you have put before us, Dr. Clowes, go to show tha you have a 126,500,000 average of bacteria per c.c. in the sludge which you send to the Barrow Deep, but from certain experiments you have carried out you find that that number is enormously reduced, reduced to about 2,500 per cubic centimetre on dilution, and that in all further experiments which you made at the London end of the Barrow Deep to test the number of bacteria in the inflowing tide you found it had been reduced to under 500?—Yes, that was so.

18702. I suppose you would consider that a safe reduction?—I think that is reasonably safe, because, as I say, we have drinking waters frequently containing that number.

18703. Now, those experiments, of course, are surface experiments?—Yes, they are; the samples were all taken out by buckets slung over the side of the steamer.

18704. The effect of the pollution arising from sludge would be much greater lower down than on the surface?—That is a matter we are arranging to investigate. The duty of the sludge steamers is lighter during the summer; we have not the river flood water to deal with, and I am hoping to get one of the large steamers told off to work in the estuary, taking samples from the bottom and from the sands, and examining them bacterially.

18705. We must take these interesting data as applying to surface water?—Yes, but the sludge floats a long time. I sometimes go down with these steamers to see how the sludge discharge behaves, and after we have discharged our sludge in the Barrow Deep, if we turn tail and go slowly back we pass through our sludge again.

18706. Does not Table B refer to 20 minutes after the passage of the steamer?—The sludge certainly would not have sunk in 20 minutes.

18707. The result of those surface experiments is very satisfactory, and shows a great improvement in the water. That would point to very rapid settlement?—It is a huge mass of water that the sludge spreads into, and I think it rather points to great dilution.

18708. In the last paragraph of your paper you do refer to some experiments in connection with the sands and deposits?—Yes, but you will notice that those were made some years ago.

18709. You are proposing to repeat those?—We used to make those examinations chemically and microscopically of the bottom of the estuary at periods of two or three years.

18710. How old are these experiments referred to?—They were made in 1889.

18711. 1889, that is a long time ago?—Yes, we shall probably repeat these experiments soon.

18712. You have not made any experiments in connection with the deposits in the Barrow Deep recently?—Not since that date, I conducted that examination myself.

18713. You are unable to tell us whether there is a great accumulation of matters carried by your sludge in the Barrow Deep?—I could not give you any statement more recent than that just referred to.

(*Chairman.*) 1899, not 1889?

18714. (*Colonel Harding.*) 1899, you say; in the printed matter it says August, 1899. Is that a misprint? Are we to take it, later on it is 1889?—It is 1899. I was not advising the Council in 1889.

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18715. That is just four years ago; you have not done anything since, but I gather you were proposing to try some experiments to see the amount of pollution which settles in the Barrow Deep?—I think I shall urge my committee to detail a boat to do that work this summer; I think they should do that.

18716. But those experiments which you did carry on go to show that there is no evidence of pollution in a northerly, southerly, or westerly direction; that is as far as miscroscopic or chemical examination is concerned?—There was no bacterial work done that year.

18717. If it is suggested to us that muds on the bank of the Crouch or the Essex coast north of that point were due to the deposit of sludge at Barrow Deep, you would think it unlikely that that would be so?—That would be improbable from the examination I made. If any of these sands are polluted it is probably due to local pollution.

18718. You do not think that mud in the neighbourhood of Whitstable or Herne Bay could possibly arise from the settling of the sludge from the Barrow Deep?—There was no evidence of sludge deposit there whatever.

18719. I would like to ask you a question or two with regard to the general question of the treatment of London sewage. It is quite evident that if you had not this opportunity of turning out your sludge into the sea the question of treating London sewage would be an exceedingly grave matter, and might possibly restrict the development of the City unless it had been satisfactorily solved. London is very fortunate in being able to carry out to sea this huge amount of sludge which it produces; but is the withdrawal of the sludge from the London sewage, in your opinion, sufficient to ensure the safe condition of the Thames Estuary?—Well, I do not know how you would define the word "safe."

18720. Let me put it another way. Have you tried any experiments to ascertain the effect of the effluent taken out at Barking and Crossness upon the water which oscillates between the tides from Gravesend to London Bridge, for instance?—Certainly, we have been watching for some years.

18721. Then what is the effect; to what extent does it pollute the river?—We have estimated it chiefly by its deoxidising effect—that in the extent to which the sewage effluent deprives the river of its dissolved oxygen. That is the most ready way of estimating its effect and we find that the deoxidation extends to a very considerable distance down river during the falling tide, and to a very considerable distance up river during the rising tide. In fact, at high spring tide at Charing Cross Railway Bridge we have found river water almost completely deprived of its dissolved oxygen. Of course, there must be other sources of pollution besides the sewage effluent, but I think that the deoxidation is mainly due to the sewage effluent. I shall be able to furnish statistics upon this matter later on. Going down river, we have found the deoxidising effect of the effluent extending on a falling tide below Gravesend.

18722. You can agree that it is not sufficient to withdraw the suspended solids from the sewage even in the case of London?—Well, the risk which we have chiefly to consider is the risk of nuisance. I do not consider that the Lower Thames water would ever be drunk. It is too muddy and salt to be used for drinking purposes, and, therefore, no risk can arise from its consumption for drinking purposes, but I do think that the river ought to be safe from causing a nuisance in the way of a smell.

18723. Then let me limit my inquiry to that point. Do you find that this almost entire removal of its dissolved oxygen from the river water does bring about actual nuisance?—I should say that the aeration of the river water would be at its minimum in the immediate neighbourhood of the outfalls; for some miles above or below this the average aeration would be something like 20 or 30 per cent. At times it falls to five per cent. of the possible, and it is then getting very near the limit where the oxygen would disappear. When once the dissolved oxygen disappears the change of the organic substances in the river water may become an offensive one, especially in hot weather. It is of a different character in the absence of oxygen and causes offence. This has occurred in the summer in the neighbourhood of Woolwich and Greenwich. There was an offensive smell from the river, which, if it had continued, would have caused us to take special remedial steps.

18724. Now your effluents from Barking and Crossness contained after precipitation still about 8 grains. Is that per gallon or per 100,000; is it 8 parts per 100,000 or 8 grains per gallon?—That is 8 parts per 100,000.

18725. Does that cause any nuisance by forming mud banks?—No, that never settles. I do not anticipate that any trouble can arise from that. It is the dissolved matters which have caused trouble.

18726. It is not suggested that your effluents at Barking and Crossness go right out to sea on the tide. There is an oscillation, is there not, of about 17 to 18 miles there?—I should think it would be possibly about that. I made an attempt some years since to ascertain how far the tide did pass up river, and we estimated the distance then by determinning the amount of sodium chloride in the river water. Its amount was appreciably increased even above Richmond.

18727. I see that in the report published in 1884 in connection with the Royal Commission on Metropolitan Sewage Discharge some float experiments were made, and the result of them seemed to show that the permanent advance towards the sea was a very slow one?—I have no personal knowledge of this.

18728. Something about one mile a day or one-half a mile a day?—I do not know about those experiments.

18729. The oscillation, the movement towards the sea, was exceedingly slow?—I have not seen the results of those experiments.

18730. The opinion having been expressed to us that the conditions of things by the discharge of the present effluents from Barking and Crossness is not satisfactory, is anything proposed to be done by the London County Council with regard to the further purification and precipitation of suspended solids?—I should explain that whilst the water is oscillating up and down it is being acted upon by purifying bacteria. The river is largely charged with purifying bacteria.

18731. You mean there is a considerable dilution taking place?—Not dilution, but action by a large number of bacteria which are constantly purifying the river water.

18732. Does not that point to the basin of the Thames being rather a sort of septic tank bringing about these changes?—It is not septic, since it takes place in the presence of dissolved oxygen, but it is useful bacterial action which is going on.

18733. The main point is about it creating practically a nusiance?—This occurs very exceptionally indeed. I have only had one case in my own experience.

18734. What is proposed by your Council in regard to further purification than the settlement of suspended solids?—When the present method of treatment was adopted—that is to say, the sedimentation of the sewage and the transporting of the solids to the sea—it was stated that a large amount of dissolved organic matter would still pass into the river in the effluent, and that if any method could be devised for dealing with this effluent so as to remove this dissolved organic matter, it would be highly desirable. At that time land was examined in the neighbourhood of our outfalls, and no land suitable for irrigation was found. It was too marshy land; and, therefore, the question of a large sewage farm had to be given up. But when the Massachusetts experiments were first published the Chemical Adviser of the Council strongly urged the Council to commence experiments on the bacterial treatment. These experiments were attended with very promising results, and when I came into office as Chemical Adviser of the Council I continued them, and came to the conclusion published in the final report on the subject, in which I stated that by the proper suitable bacterial treatment of the sewage by septic tanks, followed by coke beds, not only would the sludge be diminished vastly, probably to a greater extent than 50 per cent., but the effluent that remained would never become offensive under any conditions, but would be highly aerated and suitable for maintaining the life of fish, and I strongly recommended that this bacterial method should be adopted by the County Council.

18735. The Committee had the advantage some time ago, I forget how long ago, of a visit with you to certain experimental works at Crossness?—I had the pleasure

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of showing the experimental work of the County Council to Members of this Commission.

18736. They were on a very small scale; have they ever been extended since?—No; those experiments have never been carried out on a large scale. Since we discontinued the experiments at the outfalls Mr. Aston Webb, a personal friend of mine, asked me if I could advise him as to the treatment of sewage arising from about 1,000 people at the new school at Horsham, and my own experiments at the outfall having been so successful, I strongly urged his putting down plant of a precisely similar character. That has now been at work since the school was opened, and I have been watching it carefully; it has given satisfactory results.

18737. But we are left under the impression that the Council does not think the condition of the Thames sufficiently bad to go to the expense of trying experiments on a larger scale, and even the few very experiments which you showed us some time ago have been discontinued?—They have under very serious consideration the conduct of operations on a larger scale.

18738. But they have not done anything?—They are awaiting the report of their engineer, who will have to advise them as to the cost of construction and the character of the construction required. They are awaiting his report before they make the next step, but the next step would be certainly in the direction of putting down a larger installation.

18739. What are the general lines of the contemplated experiments; are they septic tank?—It should be septic tank treatment, followed by intermittent coke beds or bacterial beds.

18740. What are generally known as contact beds?—Yes.

18741. That is what is being tried under your advice at Horsham?—They are working entirely in that direction; they have duplicate septic tanks, followed by the necessary coke beds.

18742. You do not foresee that in treating the London sewage with septic tanks the considerable area required might give rise to nuisance?—I think not. There is no smell whatever from the Horsham septic tank.

18742.* (*Chairman.*) Is it all open?—No, it is not open. It is near the new railway station and the railway line, and although I advised that it should be left open or covered only very loosely, a cover was put over the septic tanks, with ventilating pipes rising 12ft. or 14ft. into the air, but there is absolutely no smell, and even when the manholes are open there is no smell which could be called offensive.

18743. You would propose in London to use those tanks shut?—We found that open septic tanks were quite as satisfactory as closed ones at Crossness. We worked continuously at our outfalls. The London sewage comes down day and night, year in and year out, with no intermission. But at Horsham, when the boys left for their first summer holiday—in the Jubilee Year they got a rather extra long holiday—the whole plant came suddenly to a standstill. We had not contemplated what the result of that would be. The result was that, owing to the long-continued stagnation, when the displacement of the liquids commenced after the vacation, there was an extremely foul effluent, and the smell around was certainly very offensive. We have tided over that by allowing a portion of the water supply of the College to run through the system whilst the boys are away.

18744. (*Colonel Harding.*) Although you tell us that there was no smell from these ventilating shafts from the intercepting tank, have you noticed any smell from the effluent just coming from the septic tank and passing on to the beds?—Only during the time I speak of, when there was stagnation in the septic tank.

18745. No, but under ordinary conditions of working?—That will depend upon the length of time that the sewage remains in the septic tank.

18746. What is the length of time apportioned?—Well, if I remember rightly, it is about twenty-four hours.

18747. A very short time?—We have always worked at the outfalls for five hours. That is about the time we can afford to give it in the present settling channels.

18748. Do you think, with twenty-four hours' settling in the tank, there is full opportunity for purification taking place?—No; but if it remains very much longer there is a risk of it becoming foul. Sulphuretted hydrogen is generated when it has remained in the tank for a long period, from my experience with small installations. The Council has a number of small installations in different places throughout London, and we find the longer time in the septic tank is very apt to cause nuisance, and that the work is quite efficiently done by the contact beds subsequently after only five or six hours in the septic tank.

18749. It has not been suggested, in connection with London sewage, to continue your present system of precipitation and of carrying your sludge to the Barrow Deep, and then treating the effluent so produced with contact beds?—They would have to carry their sludge still out to the Barrow Deep.

18750. You mean the sludge from the septic tanks?—The sludge from the septic tanks.

18751. No doubt they would, but I was anxious to get your opinion as to the utility of the septic tank in the future. In your circumstances, do you think that, seeing you have your vessels and everything organised, and that in regard to precipitation there is no danger of nuisance, is there no suggestion that that should be continued, and that the effluent from the Barking and Crossness works should be passed on beds of some sort?—I think it would be necessary in the future either to increase our fleet or to diminish the sludge by the septic treatment.

18752. You must reduce the volume of sludge?—We must reduce the volume of sludge or increase our fleet. I was proposing to deal with the practical difficulty arising from the deadlock in dealing with the sludge rather by reducing the sludge, because we have accommodation for septic treatment in our settling channels. There is no doubt that the effluent from the septic treatment is far more successfully treated in the contact beds than sewage which has not undergone a separate treatment.

18753. Then, anyway, you are unable at present to give us any data arising from any important experiments carried out by the County Council, but you foreshadow that very shortly some experiments will be begun?—Our experiments were scale-models of the method as it would be carried out.

18754. As far as your experience goes, treatment after sedimentation or after septic settlement upon coke beds, gives results which are considered suitable and satisfactory?—I have already strongly recommended that system of treatment.

18755. Have you any personal knowledge of the volume of trade effluents in London sewage?—It is almost negligible in comparison with the amount of domestic fluid that comes down.

18756. You do not appreciate, at the Barking and Crossness works, that any feature is due to trade effluents?—I cannot say that we do.

18757. It is always neutral, is it?—It is not always neutral. It is generally slightly alkaline; of course, that is favourable to the bacterial action.

18758. What about its temperature?—Almost uniform.

18759. What is it?—It does not vary more than two or three degrees from 55° F.

18760. What is the average temperature as it reaches Barking?—It is about 55°.

18761. With regard to water from boilers and manufacturing processes reduced below boiling point, you do not see any evil to your sewage from warm water?—No, certainly not. I do not think they would make any difference in the bacterial treatment of the sewage.

18762. In the great bulk of London sewage, not any appreciable increase, at any rate, at the outfalls?—Not any appreciable increase at the outfalls.

18763. And the London County Council have not put difficulties in the way of manufacturers and brewers, but have received their refuse into their sewers as a general rule?—We have to make exceptions in the case

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of material which would cause injury to the sewers or danger to our workmen, as has been stated by the engineer.

18764. But the cases in which that would happen are necessarily very rare ?—Yes; they would come before me almost invariably to state what is the nature of the discharge.

18765. We understood from him that an explosion had taken place in one of your sewers owing to the presence of, what was it—naphtha ?—The presence of some light oil used for cleansing purposes, dry cleaning. Instead of re-distilling, it had been discharged into the sewers.

18766. It may interest you to know that a case came to my knowledge recently in which similar matter came floating down the sewer, and caused the sewage to take fire at the sewage disposal works, and stopped the whole treatment for about half an hour. Happily, it burnt itself out before any important damage had been done ?—We had a serious accident of that sort at one of our pumping stations, not at the outfall; the pumping apparatus was partially wrecked.

18767. So it is clearly necessary in some cases to exclude trade effluents entirely ?—Certainly: the cases that more frequently occur are cases of acids being introduced into the sewer, which may attack the brickwork or the cement of the sewers, and in one case we had sulphurous acid turned in, which was very trying to the workmen.

18768. (*Chairman.*) There are only one or two questions I should like to ask you. Have you any evidence that sludge is coagulated by sea water ?—No, I do not know that it is.

18769. In looking at the experiments you saw in the Barrow Deep, did it appear to be coagulated—did it flake and cake, or did it remain very fine ?—I do not think we should have seen that if it had occurred. We were looking down from the bridge of the steamer, and we could only see a uniform black surface.

18770. The probability is it will take months to settle; if it does not coagulate it would probably remain for months?—My own impression is that it floats for a long time. Its temperature is probably higher than that of the sea water; that would tend to make it float. My impression is that it floats out to sea.

18771. Does it go in patches?—It retains its shape, as a long black streak.

18772. And gradually disappears?—Yes.

18773. Is it not possible it may carry to the coasts?—Well, not by the set of the tides.

18774. They would take it out to sea?—It is deposited on a falling tide at the Barrow Deep centrally in the estuary.

18775. Is that practice always adhered to, of letting out the sludge on a falling tide?—The Engineer explained that occasionally our steamers are delayed, and do not arrive until dead low water. That is an accident. We try to avoid that as much as possible.

18776. Coming to another subject, you have found that fish get through at Barking and Crossness; do they live in the water there?—I always, if I get a case of that kind, report it to my committee; it is not frequent. I have recently seen two photographs of very large fish which were taken at Barking outfall. But these were carp supposed to have been brought from the upper river by flood-water.

18777. Do you know anything about the amount of aeration that a fish can stand? Can it live in water with 30 per cent. aeration?—It is generally put down at about 50 per cent. I do not know what data there are for that; I find there is an idea that that is about the quantity required.

18778. Is it not the case that small fish live very near the outfall, and apparently eat the particles that come through?—I have never seen any fish anywhere in the main stream near the outfall. I have seen them frequently near the outlets from our coke beds in a well-aerated effluent. I have never seen them myself in that part of the river, and I am pretty frequently watching it.

18779. Were there not some experiments made to try whether salmon could not be successfully towed up the Thames?—It was proposed to make some experiments by towing salmon in perforated boxes along the river; but I believe these experiments were never made. Large numbers of young salmon have been put into the river at Teddington with the idea of stocking the river.

18780. Do they appear again?—A salmon was caught at Molesey, but I have never seen any in the lower river.

18781. Could you tell us how much precipitant you use per ton of sludge—give us some rough idea what the relative weight of precipitant to sludge is?—Well, the amount of precipitant added is 4 to 5 grains of lime and 1 grain of crystallised sulphate of iron per gallon of sewage; you would like it carried out to sludge.

18782. It would be interesting to see what it does weigh?

18783. What proportion of the sludge is precipitant?—About 2 per cent. of the wet sludge is the precipitant.

18784. Do you press your sludge or simply ship it?—We simply ship it in a liquid condition, keeping it fluid so as to readily pump it into the tanks of our steamers.

18785. Have you calculated whether it costs less to press it or to carry it in steamers?—Pressing was tried many years ago. I have no personal experience of it. The cakes of sludge were attempted to be sold to the farmers for manurial purposes, but after a short experience I understand they declined to take these cakes.

18786. Has it never been suggested that the pressed sludge might be taken out to sea? You carry, I suppose, 90 per cent. of water?—About 92 per cent.; but it is hardly fair to call that ordinary water. Air-dried sludge contains about 75 per cent. of water. Chemists look on this as water in combination; it is therefore hardly fair to speak of the sludge as containing 92 per cent. of liquid water.

18787. My impression was that in pressing sludge you might reduce it to 50 per cent.?—Yes. Air-dried sludge, as I say, according to my experience, contains about 75 per cent. The Council naturally objects to carrying an undue proportion of water, but they certainly cannot economically reduce the percentage appreciably below that usually present in the sludge.

18788. It appears to be entirely a matter for the Finance Committee to ascertain whether it would not be much cheaper to press the sludge, and so have to carry less water than you carry. You carry a large quantity of water for which you have to provide a fleet of steamers, and many other things?—Of course, dealing with fluid matter is much more simple than with solid matter, the pumping, transport, and disposal of liquid sludge altogether is much more simple than dealing with solid cakes.

18789. (*Colonel Harding.*) On the point you raise, I see there is some information in the engineer's evidence. He there said that the sewage as it reached Barking contained on an average 33 grains of suspended matter per gallon; that the effluent contained 8 grains, and therefore that there was left behind, roughly, 25 grains per gallon, and that there were added to the sewage 4 grains of lime and 1 grain of sulphate of iron; that is to say, 5 to 25. I assume, therefore, that the effect of the addition of chemicals to the sludge would be to increase its volume 20 per cent.

(*Chairman.*) Twenty per cent., yes.

Dr. HERBERT WILLIAMS, M.D., Medical Officer of Health of the Port of London, called; and Examined.

Dr. H. Williams, M.D.

18790. (*Chairman.*) You are Dr. Herbert Williams, Medical Officer of Health of the Port of London?—Yes.

18791. Can you tell us what shell fish grounds lie within the jurisdiction of the Port of London Sanitary Authority? Would you mind pointing it out on the map; there is a large map behind you?—There are cockle grounds in this vicinity (*indicating on map*), opposite Canvey Island, on the Blyth Sands. There are some on the Jenkin Spit, off the Island of Grain; there are cockles scattered about here; here is a place called Leigh Creek, where it has been the custom until the

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end of last year to store the cockles for a period of about 48 hours, in order that they might purge themselves of sand and fill themselves up with the filthy mud which is in the Creek. There are oyster beds scattered about here which are only used in the vicinity of Southend, but from Shoeburyness for a distance of about eight miles to the north-east are the large cockle grounds, and boats go here and collect the cockles.

18792. Nearly opposite Foulness Island?—Yes, from here to about eight miles to the east or north-east. They are brought from there to Leigh-on-Sea, where they are boiled and distributed; some also go to Southend. The district of the Port of London Sanitary Authority also extends from Rochford down the Roach, round here, which is called Havengore Creek, and includes Potton and Rushley Islands. There are oyster beds in the Roach. Roughly, that is the extent of the shell fish grounds within the jurisdiction of the Port of London Sanitary Authority.

18793. Whitstable is not within your jurisdiction?—Whitstable is not. We go as far east as this point here, which is Warden Point, and we also go up the western arm of the Swale as far as Elmley Ferry, and I should mention that there are oyster grounds in this western end of the Swale, that is the eastern limit of the Port of London; the eastern end of the Swale is in the Port of Faversham; Whitstable and Faversham are not within our district.

18794. Would you give us some information as regards the shell fish grounds in reference to enteric fever?—The shell fish grounds and "layers" that are situated within the jurisdiction of the Port of London Sanitary Authority are as follows:—

Estuary and mouth of the River Thames and its tributaries. On the Essex shore: Chapman Sand, Leigh Creek and vicinity, Southend Flats, Maplin Sands, Rivers Roach and Crouch with creeks.

On the Kentish shore: The Swale (western portion with Queenborough Creek), Blyth and Jenkin Sand.

In January last it was reported to me that certain cases of enteric fever had been attributed to the eating of shell fish purchased in the City of London.

Samples of cockles were submitted to Dr. Klein for bacterioscopic examination, whose report is annexed hereto.

Upon ascertaining that these cockles were collected and brought to Leigh-on-Sea in Essex, I, on January 3rd, visited the place and discovered that it was the practice of the fishermen to collect the cockles in the Thames Estuary on the Maplin Sands, bring them to Leigh, lay them in Leigh Creek for a variable period until they were ready for market, or had purged themselves of the sand from the gathering grounds. I took samples of these cockles and of the mud from Leigh Creek, and submitted the same to Dr. Klein for analysis and report.

St. Bartholomew's Hospital and College,
January 7th, 1903.

The following is the, as yet, incomplete report of the bacterioscopic analysis of the three samples received here on January 5th, per Dr. Williams:—

1. One sample of water, labelled "Water taken from Leigh Creek, low tide, 11.30 a.m., December 3rd, 1902."

2. One sample of mud and cockles from Leigh Creek, low tide, taken by Medical Officer of Health, January 3rd, 1903.

These samples will be nominated:—

Water from Leigh Creek,
Mud from Leigh Creek, and
Cockles, No. 10, respectively.

A. Water.—This water contained at least $\frac{1}{4}$ million microbes per 1cc. The water contained abundance of bacillus coli communis and spores of bacillus enteritidis sporogenes, of the latter at least 10 spores per 1 cc., of the former at least 100 per 1 cc.

From this it follows that this water is practically dilute sewage.

B. Mud.—One gramme of mud was distributed in 10 cc. of sterile water; after allowing the mineral matter to settle, of the slightly turbid fluid, $\frac{1}{10}$ cc., $\frac{1}{4}$ cc., and 1 cc. were used for demonstrating the presence of bacillus coli communis and the spores of the bacillus enteritidis sporogenes, and the result was practically the same as stated of the water, viz., abundance of bacillus coli communis and of spores of bacillus enteritidis in $\frac{1}{10}$ cc.

C. Cockles, No. 10.—Twelve of the cockles were used, only the exterior being employed. The result was this:—All cockles contained the bacillus coli communis and the spores of bacillus enteritidis. In one (possibly two) cockle, we isolated, besides, a microbe, which, so far as was possible in the two days, answers to the tests of typhoid bacillus, but, of course, this time is not sufficient to make a definite statement on the subject. I may, however, add that typhoid blood agglutinates the emulsion of the bacillus in question as 1 in 100, better, of course, as 1 in 50.

E. Klein.

Dr. Klein further reports that from the cockles numbered 10 "the typhoid bacillus, or at any rate a bacillus corresponding to it, and answering all the tests of the bacillus typhosus, was discovered in them."

The system of sewage disposal adopted at Leigh-on-Sea was, I am informed, until 1900 principally by cesspools.

In that year sewage disposal works were erected on the adjacent marsh, the effluent from which in due course flowed into the Thames Estuary, the sludge being disposed of on the land.

With regard to the effluent, Mr. H. Douglas Watson, the Medical Officer of Health for Leigh, reports that although chemically the effluent is considered purer than crude sewage, it would not be sufficiently pure for use as a source of drinking water, and that it was inadvisable that shell fish be laid near the outfall, unless the effluent were rendered innocuous.

The incidence of enteric fever in Leigh-on-Sea was remarkable, and the Medical Officer on that question reports that the facts point to "some source of infection constantly present, such as polluted shell fish, and the cases occurring in other districts and traced to the consumption of Leigh cockles made the circumstances very strong."

At Southend-on-Sea crude sewage is allowed to flow into the estuary every ebb tide, the flow commencing directly after high water.

An outbreak of 19 cases of typhoid fever in Southend in June, 1902, was, in the opinion of the Medical Officer of Health, almost entirely due to the consumption of infected cockles from Leigh.

At Sheerness also crude sewage runs into the mouth of the Medway from a series of outfalls along the foreshore. At Shoeburyness the sewage is poured out in a crude state over the Maplin Sands, from which source cockles are gathered. It is clear that the whole bed of the mouth of the River Thames and approaches is extensively polluted with sewage, and shell fish collected from places near the shore do show evidence of pollution by sewage. The sections of the Public Health Act relating to unsound food, although giving to the Sanitary Authority's Medical Officer of Health a certain amount of power, are not and cannot be made applicable to shell fish, inasmuch as action in the circumstances under consideration could only be taken on the result of a bacteriological examination. As this takes several days, the difficulty is obvious.

The Port of London Sanitary Authority have communicated with the Local Government Board asking that powers may be granted to enter upon and inspect any shell fish laying grounds, and, if found to be dangerously polluted with sewage, to prohibit the further laying of shell fish. The Port of London Sanitary Authority are also strongly of opinion that the discharge of large quantities of sewage into the waters of the estuary of the Thames in proximity to shell fish gathering grounds or "layers" is dangerous to the public health, and that it is desirable that the crude sewage should be so treated that the said danger may be minimised, if not got rid of altogether.

The machinery suggested for the prevention of the pollution of water has for its object the discharge into the sea or river estuary of an effluent which shall be non-putrescent, and in which it is fair to assume that any pathogenic organisms existing in the crude sewage shall be either got rid of entirely or so diminished in number that the probable risk of their spreading disease to human beings shall be minimised, if not entirely abolished.

The Corporation of the City of London are decidedly of opinion that where crude sewage is discharged under conditions which may involve the probability of the contamination of shell fish, great risk of spreading exists, and that such sewage should be previously treated in the manner suggested.

The Corporation of the City of London, as the Port Sanitary Authority having under its jurisdiction a large stretch of water which is extensively used by the public, especially in the summer time, for pleasure and health purposes, including bathing, etc., are of opinion that no stone should be left unturned to so purify the sewage effluents going into the river that its condition as to purity shall be improved to the highest possible extent.

18795. Has the Port of London Sanitary Authority got any idea as to how the present state of things should be improved?—They think that the first point should be the control of the shell fish on the grounds—that is to say, that there should be power of entry on such shell fish ground, with power to take samples, and if they are found to be contaminated with sewage, and therefore potentially a source of danger, they should have the power to prohibit the collection, sale and distribution of shell fish from such grounds until it be shown that they are free from dangerous sewage contamination

18796. Would you give that power to the sanitary authority, or would you merely make them the reporting authority to some other body which should have the power? I think in the case of London it should be under the control of the Port of London Sanitary Authority.

18797. The district is, of course, a very large one?—It is a large one, and it is, as you know, administered by the Corporation of the City of London, who delegate their powers to a committee consisting of about 30 members, one member being appointed on the Port Sanitary Committee from each ward in the City.

18798. Would you consider such a committee sufficiently unprejudiced?—I think so.

18799. None of them are owners of fishing grounds?—I think there are two members who are interested in the sale of shell fish, but my experience of the Corporation of the City of London is that they would not allow any member to air his business interests, especially on a question of public health.

18800. Would they command the confidence of the owners of the shell fish beds in the case of oysters?—I think they would.

18801. And in the case of any dispute, would you suggest any authority to which appeal could be made?—Certainly, it should be the central authority.

18802. Have they at present any power whatever over these shell fish beds?—They have no power whatever over these shell fish beds. The only powers possessed by the Port of London Sanitary Authority are certain vague powers under the Public Health Act, especially the clauses relating to unsound food, and it is not found practicable for the Port Sanitary Authority to apply those clauses with any prospect of success.

18803. (*Major-General Carey.*) Do you consider that the cockle beds on the north and south foreshore of the Thames and also on the north-east of the Maplins are directly liable to sewage pollution?—Certainly, sir.

18804. From Southend?—May I point out that Leigh discharges its sewage on to this island into a tank, or collection of tanks, where it goes through what is known as the "septic tank" process, and then the liquid from there is allowed to run out, and it flows down the creek *here* in this neighbourhood towards Southend (*indicating on map*), and the set of the tide follows almost the contour of the land, with a little tendency to go off. Southend discharges its sewage *here* just at the end of the pier. It is discharged on the first four hours of the ebb tide. That flows down *here*. The current is not very strong, and it has time to settle over those sands. Shoeburyness is also a source of pollution. There are two or three outfalls *here*, some from War Office property. That also flows in the same direction, so that there must be considerable pollution of the whole of the Maplin Sands.

18805. Will you show the position of the cockle beds on the Maplins?—The cockles are scattered about; you can collect cockles all over those sands at almost any part; *there* are patches where they are more in number than others, but they are generally distributed.

18806. Are they collected by certain owners, or are they taken indiscriminately by the people?—There are certain people who have a right of collecting them; certain men have prescriptive rights, so that it is really under the control of a few persons as regards the collection of large quantities, but really there is nothing to prevent anyone going on the sands there and collecting them. There is the Blyth Sand. It is not so easy to trace the source of pollution there. *Here* is a fort called Slough Fort belonging to the War Office. It discharges its sewage in a crude state on to the sands. The whole of the sewage of Sheerness is discharged in the Medway opposite West Minster, and when it is discharging it is very crude sewage, very offensive, and very black. That sewage flows down and forms an eddy, so that the sewage is distributed on the sands above the pier. I omitted to mention that in this locality there are a few scattered mussels and cockles which are collected indiscriminately by the public of Sheerness, so that all these sands and the cockles are contaminated. In addition to the sewage collected *here* on the flood tide it would be carried up the Swale, in which there are extensive oyster beds.

18807. (*Chairman.*) The sewage of Gravesend is discharged into the river, is it not, or into cesspools?—Gravesend is a cesspit town, but there is a certain amount of sewage discharged into the river. The houses lying along the river *here* do discharge a certain amount of crude sewage into the river Thames. The musketry depot at Gravesend, which is sometimes occupied by 1,500 to 2,000 men, also discharges its crude sewage into the Thames just about *here*. There are a few mussels found about there, but there are no shell fish in the immediate vicinity.

18808. Would you consider that that pollution extends up or down the river, the sewage that comes in at Gravesend?—The Gravesend pollution?

18809. Yes?—I think that pollution would go down the river, and as the ebb tide is very strong there, it would be carried away to sea.

18810. You do not think the London sewage, at any rate at Crossness or Barking, is prejudicial to the condition of the river?—It is not a pure effluent.

18811. No?—It is an effluent which is capable of considerable improvement.

18812. Does it affect places like Leigh and Southend and round by Foulness Island and the Crouch?—As a practical question of danger I do not think that the outfall at Barking would be in any way comparable with the local pollution in the neighbourhood of Southend.

18813. (*Major-General Carey.*) And have any suggestions been made by the Corporation of the City of London that the Southend sewage should be treated?—They have made representations to all the local bodies which have been observed to pour sewage in a crude state into the Thames, requesting them to alter their present system of sewage disposal. It is only in the form of a written intimation.

18814. Nothing has been done?—Nothing further has been done. It is under consideration by the Law Officers of the Corporation, and the committee are still considering the next steps that are to be taken.

18815. Would that crude sewage from Sheerness possibly affect the Whitstable oyster beds?—No, I think not, sir; my own personal opinion is that sewage acts prejudicially in proportion to the vicinity of the outfall to the shell fish beds.

18816. (*Chairman.*) Do you think that the treatment of sewage would minimise the danger; do you not think that sewage effluent is less dangerous than crude sewage as far as shell fish is concerned?—You mean after it has been treated.

18817. Yes?—I think, judging from the reports of the scientific observers, they rather tend to show that although the danger is not got rid of entirely yet it is considerably minimised, that is to say, if you can produce a sewage effluent which is chemically and bacteriologically purer and freer from organisms generally than crude sewage, you diminish the danger proportionately.

18818. But you would rather trust to putting the sewage outfall at a greater distance if possible from shell fish beds, would you not?—Certainly, or removing the shell fish beds from the vicinity of the outfall.

18819. Suppose the sewage itself were purified, more or less, where could the shell fish beds be removed to?—

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You could not remove the shell fish beds except to prohibit their use.

18820. Do you not think that would be going a little too far ?—I think it would ; I think the owners would have a just cause of complaint.

18821. (*Mr. Stafford.*) Within what area do the Port Sanitary Authority of London exercise jurisdiction ?—Eastward from a line drawn from Havengore Creek in Essex to Warden Point in the Isle of Sheppey. Originally the Port of London Sanitary Authority had jurisdiction to the North Foreland, a line drawn from the North Foreland to the Naze, but the Port of London has varied in its jurisdiction according to the limitations or the delimitation of the port as laid down by the Treasury for Customs purposes. We follow exactly the limits of the port as laid down by the Treasury Minute dated 1st August, 1883.

18822. Are representatives appointed from the various places on the coast on either side ?—No ; the whole is administered by the Corporation of the City of London. There are no representatives from any local body on the shore, and there are no contributions from the local authorities in the way of money. The whole expense of the Port of London Sanitary Authority is borne entirely by the City's cash, and I think that is another reason for assuming that you might have a certain amount of independence and freedom from local influence.

18823. But the Port Sanitary Authority are dealing mainly with the seaborne cases of disease ; is not that so ?—Mainly, but they also have the sanitary supervision of all the vessels within their jurisdiction.

18824. Quite so, but they are dealing practically with the sea ?—I do not quite understand your question.

18825. They are dealing with the sea ; it is a matter of sea commerce that they are dealing with ; the health of incoming and outgoing vessels ?—And also the people who are within their jurisdiction. On vessels there is a large population.

18826. On vessels, yes ?—And there are also large quantities of foodstuffs landed in the Port of London.

18827. That are carried by vessels ?—That are carried by vessels.

18828. But now you want to extend that to the shores, and to deal with the pollution of certain sorts of shellfish ?—But as a Sanitary Authority it has to investigate the origin and causes of disease which originates within their district.

18829. Have they ?—Certainly.

18830. As a Port Sanitary Authority ?—As a Port Sanitary Authority it makes no difference ; they are simply called a Port Sanitary Authority because they happen to administer a port for sanitary purposes.

18831. What right of interference have they, for instance, at Gravesend or Sheerness ?—If I can demonstrate the existence of a nuisance they can interfere.

18832 On the shore ?—On the shore up to high water mark my Authority can call upon the Sheerness people to abate that nuisance and take steps to prevent its recurrence in the same way as the local authority could if a nuisance were committed on shore above high water mark.

18833. Quite so. What answer did the Local Government Board give you ? You quote here in your statement: "The Port of London Sanitary Authority have communicated with the Local Government Board, asking that powers may be granted to enter upon and inspect any shell fish laying grounds." Well, would you not have that power if you have the power of dealing with a nuisance on the shore ?—No, because it is so hard to demonstrate satisfactorily in a court of law that there is a nuisance. May I just quote an example of what would happen ? Here is a discharge of sewage in the Medway at West Minster ; there are no houses in the immediate vicinity. I have had no complaint from anyone as to that nuisance. If the Port of London Sanitary Authority were to serve a nuisance notice on the Urban District Council of Sheerness requiring them to abate the nuisance and take steps to prevent the recurrence thereof, and if they failed to comply with the terms of that notice a summons would have to be taken out against the Urban District Council of Sheerness, which would have to be heard at Sheerness before a local bench composed of people who would be directly influenced pecuniarily if the terms of the notice were complied with.

18834. And you have absolutely the right of entry at Sheerness and Gravesend ?—Anywhere up to high water mark. Not in the town of Sheerness itself, but anywhere from Teddington Lock to a line drawn from Havengore Creek to Warden Point, and up the river Roach as far as Rochford.

18835. And what are your powers of dealing for instance, with Southend and making them treat their sewage properly ?—Exactly the same as it would be in the case of Sheerness ; we would have to demonstrate the existence of a nuisance, and work under the nuisance clause of the Public Health Act.

18836. Have you made any representations to Southend and other places where the sewage has not been properly treated ?—Yes, representations have been made, and my committee have under consideration, in consultation with their legal officers, what are the next steps which are to be taken.

18837. And what are your powers of enforcing your views as regards the treatment of sewage ?—The powers would be under the Public Health Act. You first of all have to show the existence of a nuisance ; you then call upon them to abate it, and prevent its recurrence. If they do not take steps to prevent the recurrence of this nuisance, you then apply for a summons before the local Bench and in default of compliance there is a fine of a certain sum per day during which the nuisance continues.

18838. So that if Southend and the several places that you point out to us in which the sewage has not been properly treated and has been discharged in that improper manner, do not treat it properly and discharge it in a proper manner, we may look to the Port Sanitary Authority of London as being responsible for that ?—No, not as being responsible for it.

18839. Not as being responsible for allowing it to continue ?—No, I think not.

18840. Have they not got the power to stop it ?—Well, I have just explained to you. You see the cumbersomeness of the machinery with which we have to act ; and I cannot go beyond that.

18841. But there would be proof of nuisance ; you think that a nuisance exists in Southend and other places where they do not treat their sewage ?—That is the point which is now under consideration by my committee.

18842. You have got in view the fact that you may possibly be able to stop it, and you mean to try ?—We may be able to summon the people, and we may get a conviction ; I think it is extremely unlikely.

18843. You say here you asked the Local Government Board that you might be granted powers to inspect shell fish layings. What was the reply to that ? That they were not able to give them to you, I suppose ?—Naturally the Local Government Board, I think perhaps rightly, say the whole question is under the consideration of this Commission, and until they get the report of this Commission they are unable to frame any legal measure for dealing with it.

18844. You say if dangerously polluted ; have you formed any idea yourself as to what constitutes dangerous pollution ?—Well, one would not only take into consideration the bacteriological examination. I think it may be defined as the extent to which it was shown bacteriologically to be polluted, as well as the extent to which it was observed to be actually in danger of pollution by crude sewage. For example, any shell fish layings here (*showing on map*), we should consider must be dangerously polluted, even without a bacteriological examination.

18845. And liable to pollution ; what is your remedy as regards shell fish ?—Well, the first remedy should be to have powers to control the collection and disposal of shell fish. And consequent upon that is to minimise the risk in the other direction by requiring the people to adopt measures to minimise the risk of pollution from their sewage ; in other words, to purify it to the greatest possible extent.

18846. Suppose you were absolutely satisfied with the methods adopted at Southend, do you think that even then you would recommend the Port Sanitary Authority to consider that shell fish laid here might be used with impunity ?—From the immediate vicinity ?

18847. Yes ?—It would depend very much upon the effluent produced at Southend.

18848. Take it even from the Barking outfall works?—No; certainly not.

18849. Even if Southend were blotted out and all pollution on either side of the estuary was eliminated, would you still recommend that, having regard to the treatment of sewage at Barking, oysters laid at Southend might be used?—I do not really think that the pollution from Barking would materially affect the oysters at Southend. That is an example where you would have to take into consideration the distance of the source of pollution from the shell fish laying.

18850. It is therefore the local pollution that you would go upon?—I look upon the local pollution as the great source of danger.

18851. But you think you might with impunity use the shell fish if the local pollution is taken away?—If it is taken a good distance away.

18852. Then arises the question of distance?—Quite so.

18853. It is not easy to define it, is it?—No; but that is a matter in which I think you might get some practical opinion as the result of experiment and as a result of observation.

18854. There is nothing you would suggest to the Commission by the way of distance?—No; I have no evidence or experience in the matter. There is a certain amount of evidence that oysters which are collected at Whitstable from the depôts here, two to three miles from the coast, show no evidence of sewage contamination. I believe that has been demonstrated by Professor Klein. There is a lot of sewage poured in at Whitstable, and a lot comes out at Faversham.

18855. (*Chairman.*) The water over the oysters does show signs of sewage pollution?—I do not know; I was speaking of the oysters themselves.

18856. (*Colonel. Harding*) Do you think that the control of the pollution of the estuary of the Thames is best placed in the hands of the Corporation of London?—I think so, sir.

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18857. You do not think that a body embracing a much larger area, representing, in fact, the watershed of the Thames, and upon which there would be representatives of the different counties bordering on the Thames, would be a better body to deal with the control of pollution that takes place?—I do not think they would be a better body. I think the Commission has agreed upon the importance and the necessity of a Central Authority, and the question now comes of the appointment of the peripheral authorities, and I understand from the report of the Commission you approve of the appointment of Rivers Boards based upon watersheds.

18858. Yes; my question was whether you thought the question of the pollution of the Thames, of the total of the Thames, would be best left in the hands of the City of London or placed in the hands of a watershed authority?—I think it would be best left in the hands of the Corporation of the City of London. I think they would fulfil all the requirements that you would consider necessary in the case of a Rivers Board.

18859. And that would be limited, of course, to the tidal waters?—It would be limited either to the extent of the jurisdiction it already possesses or to any extended jurisdiction that may be assigned to it for the purpose of shell fish.

18860. (*Chairman.*) Then would its jurisdiction march with the Thames Conservancy Board; would the Thames Conservancy Board deal with the upper reaches of the river?—The Thames Conservancy Board would deal with the upper reaches above Teddington in the same way as they do at present.

18861. Would it not be better to make it one Board, because one may conceive it may be polluted before it reaches Teddington? Of course, there is no shell fish?—There is no shell fish. I think for the practical purposes of shell fish we may neglect that condition.

SIXTY-THIRD DAY.

Wednesday, 15*th July,* 1903.

PRESENT:

The Right Honourable The Earl of Iddesleigh (*Chairman*), presiding.

Sir Michael Foster, K.C.B., F.R.S., M.P.
Major-General Constantine Phipps Carey, C.B., R.E.
Colonel T. W. Harding, J.P.
Mr. T. J. Stafford, F.R.C.S.I.

Mr. F. J. Willis, *Secretary.*

ALSO PRESENT:

Dr. A. C. Houston, M.D.
Dr. H. T. Bulstrode.

Mr. Shirley Murphy, Medical Officer of Health of the County of London, called; and Examined.

18862. (*Chairman.*) You are Mr. Shirley Murphy, the Medical Officer of Health for the London County Council?—That is my office. I have endeavoured in the following summary to give such information as I have been able to obtain on the question of the extent to which polluted shell fish contributes to enteric fever in London.

It has been impossible for me to make personal inquiry into the circumstances of the numerous cases of enteric fever in London, and I am indebted to the medical officers of health of the metropolitan boroughs for information as to whether antecedent to attack the patient had eaten shell fish, and for other particulars.

I have taken the last completed year, 1902, for special consideration, but before submitting certain figures and diagrams to the Royal Commission I must point out that the number of cases on which they are based must be regarded as falling short of the complete number. Inquiries made by numerous people are not in their results as satisfactory as a precise inquiry made by one person, and, further, London medical officers of health, in endeavouring to learn whether persons suffering from disease have eaten a particular article of food, have often to depend upon information supplied by the friends, owing to the fact that in a number of cases the patients had already been removed to hospital before the officer making the inquiry arrived at their homes.

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In order to obtain some indication of the number of cases which might possibly have had their origin in the eating of shell fish, I asked the medical officers of health to supply me with particulars of all the cases of enteric fever in 1902 in which shell fish had been eaten shortly before attack.

In this way the total number of cases of which I was informed is 253 in 1902. The total number of cases of

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enteric fever notified in London in that year was 3,412. The number 253 is 7·4 per cent. of the 3,412. I think, however, it would be safer to exclude the replies from five districts, and if this be done the proportion is 9·6 per cent. I have only been able to learn the interval of time between the eating of the shell fish and the onset of symptoms in 146 cases. In 12 of these cases the interval did not exceed a week. In 6 others it was a week or less from the last shell fish meal, but more for earlier shell fish meals. If the 12 cases be excluded, and also 7 others in which the interval was more than three weeks, a total of 127 remains, or 87 per cent. of the 146 cases. If this proportion be accepted for the whole of the cases, that number then falls to 217, which is 8·4 per cent. of the total cases of enteric fever in all London excepting five districts.

The question has, of course, to be considered whether this is in excess of the proportion of shell fish eaters in the London population, or, more precisely, the proportion of persons who have eaten shell fish during not less than one and not more than three weeks before a particular date. This figure cannot be given.

The practice of eating shell fish differs very much in different parts of London. Among the working classes it is often considerable. Thus, Dr. Hamer, inquiring in September, 1900, into a local outbreak of enteric fever in Southwark, found that about half the families living in the area concerned had one or more shell fish eaters in each family; and Dr. Priestly, inquiring into the question in connection with cases of infectious disease other than enteric fever in Lambeth, found that in 100 cases 37 had eaten shell fish in the earlier two of the three weeks preceding the attack. His proportion of enteric fever cases who had so eaten was 12·7 per cent. The shell fish which Dr. Hamer found to be eaten in September, 1900, were periwinkles and mussels.

In the absence of knowledge of the proportion of the London population eating shell fish, I have endeavoured to learn whether any lesson is taught by the Southend outbreak of last year, very many people from London visiting Southend for the day and longer periods, some eating shell fish there, and some eating shell fish from Southend and Leigh in London. In speaking of Southend shell fish, I do not distinguish between Southend and Leigh.

In the accompanying diagram (IV.), based upon notified cases of enteric fever in Southend and London in 1902, it will be seen that a marked increase of cases of entertic fever in Southend during the period (23rd-30th week) attributed by Dr. Nash to the eating of shell fish was accompanied by increased prevalence in London in the period 25th-30th week, this increase being especially marked in London in the 29th and 30th week. There was also an increase in London in the weeks following the 34th, week to which I shall refer later. (*See diagrams following page* 130.)

As regards the first increase, that of the 25th-30th weeks, this was followed by rapid decrease.

The number of cases among shell fish eaters in relation to the total number of cases of enteric fever in London in the two periods, viz., the period of increase and the period of decrease, was as follows:—

Period.	Number of cases which had eaten shell fish.	Number which had eaten Southend shell fish.	Number of cases which had eaten shell fish per cent. of total cases notified.	Number of cases which had eaten Southend shell fish per cent. of total cases notified.
25th to 30th week - - -	39	11	10·2	2·9
31st to 34th week - - -	19	11	9·8	5·7

So far as these figures go, it would not appear that Southend shell fish contributed in large degree to this prevalence.

Moreover, the question is complicated by the fact that in the 24th and 25th weeks there were floods in the London rivers, and I cannot exclude the possibility that drinking water contributed to this prevalence, especially in view of the relation found in 1894 between floods in the rivers and subsequent increase of enteric fever in London and in the area round London deriving their water supply from these rivers.

As regards the second increase, this corresponds in point of time with the normal autumnal increase, but it will be noted that the proportion of shell fish eaters among the sufferers from enteric fever in London increased. The increase would, of course, be explicable on the hypothesis that there was corresponding increase in the number of shell fish eaters, but I am led to think, and especially from what is known of Southend, that this explanation is inadequate. The following figures are illustrative of this increase, and it will be observed that eaters of Southend shell fish in the last two periods constituted a larger proportion of total shell fish eaters attacked than in the two earlier periods.

Weeks.	Number of cases which had eaten shell fish.	Per cent. of total cases of Enteric Fever.	Number who had eaten Southend shell fish.	Number of cases which had eaten Southend shell fish, per cent. of total cases notified.	Southend cases per cent. of cases which had eaten shell fish.
22nd to 26th -	13	4·9	3	1·1	23·1
27th to 31st -	38	11·8	12	3·7	31·6
32nd to 36th -	32	11·1	20	6·9	62·5
37th to 41st -	84	19·2	48	11·0	57·1

Numerous inhabitants of London visit Southend during the summer months. I have endeavoured unsuccessfully to learn the number so carried by the railway companies. The figures I have obtained show that in the eight weeks ended September 27th, the cases of enteric fever who had eaten shell fish at Southend were 58, during which 557 cases of enteric fever had been notified in the whole of London, excluding the five districts already mentioned. Although I cannot, for the reason stated, show the incidence of enteric fever on Southend shell fish eaters, compared with that on the remainder of the London population, it will be observed that Southend shell fish cases constituted an especially large proportion of total shell fish cases at that time of year (see diagrams I. and III.).

I am not doubting that cockles eaten at Southend caused enteric fever both at Southend and in London, and I think it is therefore necessary to consider cases of enteric fever associated with the eating of shell fish not known to come from Southend.

Diagram III. shows the total enteric fever cases which had eaten shell fish per cent. of the total number

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notified in each month of the year 1902, and it will be seen that there was marked increase in June, July, August, and September. It is interesting to observe that if what I may call the Southend cases are deducted, and the remainder stated diagramatically as a proportion of the total enteric fever cases of London, there is not more difference in the proportion of such cases in one and another month than may be expected in view of varying seasons in which shell fish of one and another kind is procurable, and of the opportunity afforded by holidays for indulging in this way.

I may add further that as a matter of mathematical probability, owing to the smallness of the figures, that, apart from other circumstances, the number of shell fish eaters in a month who suffered from enteric fever in proportion to the total number of cases of enteric fever occurring in the month would not be the same.

This has been stated for me diagramatically by Mr. G. H. Day, of the Council's Public Health Department. The diagram is based on the fact that about 300 cases of enteric fever occur monthly in London, and on the assumption that 5 per cent. of the population are habitual shell fish eaters.

The diagram (VII.) may be briefly explained as follows:—

If the Southend cases be excluded, the proportions in each month of shell fish cases to total cases of enteric fever (see diagram III.) exhibit but slight variations. Thus the average proportion of such cases for the whole year works out at 6·1 per cent., the highest proportion in any one month being 8·6 per cent., and the lowest 2·0 per cent. If the proportion of shell fish eaters in the population (assuming all shell fish eaters to be habitual consumers of shell fish) could be shown to be 6·1 per cent., the variations in the proportions shown in the diagram are consistent with the variations which might be expected to occur as a probability, and the hypothesis of causal relation between attack by enteric fever and the eating of shell fish would be unnecessary to account for the variations observed. To make this more clear, Mr. Day has calculated the probability that out of 300 cases of enteric fever, one, two, three, four, etc., of the cases would have a history of shell fish eating prior to attack in a community containing 5 per cent. of habitual consumers of shell fish. The probability curve has been shown diagramatically, and the results may be broadly stated as follows:—

> The probability that thirteen to seventeen cases, or between 4 and 6 per cent. of the total cases would be shell fish eaters is one in two.
>
> The probability that eight to twelve cases, or between $2\frac{1}{3}$ and $4\frac{1}{3}$ per cent., of the total cases would be shell fish eaters is one in four.
>
> The probability that eighteen to twenty-two cases, or between $5\frac{2}{3}$ and $7\frac{2}{3}$ per cent., of the total cases would be shell fish eaters is one in five.

If, therefore, 300 cases of enteric fever be assumed to occur each month in such a community, and the proportion of shell fish eaters attacked were shown for each of the twelve months in a year, it might be expected on the theory of probabilities that in any six out of the twelve months the proportion would range between 4 and 6 per cent.; in three out of twelve months the proportion would range between $2\frac{1}{3}$ per cent. and $4\frac{1}{3}$ per cent; and in the remaining three months the proportion would range between $5\frac{2}{3}$ per cent. and $7\frac{2}{3}$ per cent. In other words, for the whole twelve months the average proportion of shell fish cases would approximate to 5 per cent.; about six of the twelve proportions shown would probably approximate to this average, and the remaining six would probably vary between $2\frac{1}{3}$ per cent. and $7\frac{2}{3}$ per cent., three being below the average for the year and three above. It will thus be seen that the contour of a diagram constructed on these purely theoretical considerations would not differ very materially from that shown in the diagram previously referred to (diagram III.), which is based upon such facts as I have been able to obtain.

There is, I think, some reason for thinking that less shell fish has been consumed in London this year than last owing to the publicity which has been given to the risk of eating polluted shell fish. It is interesting to note that the number of cases notified in the first 24 weeks of this year is less, and especially when allowance is made for increase of population, than in the corresponding period of any previous year since 1889, when notification became compulsory.

The following are the numbers notified in this period in successive years:—

Year.	Notified cases in first 24 weeks.	Notified cases corrected for increase in population.
1890 - - -	725	800
1891 - - -	1,040	1,136
1892 - - -	720	778
1893 - - -	1,030	1,102
1894 - - -	1,124	1,192
1895 - - -	1,171	1,231
1896 - - -	1,094	1,142
1897 - - -	989	1,026
1898 - - -	790	815
1899 - - -	1,152	1,183
1900 - - -	1,591	1,627
1901 - - -	1,086	1,102
1902 - - -	973	980
1903 - - -	648	648

The corrected average of notifications in this period for thirteen years, 1890-1902, works out at 1086 cases, which is 438 in excess of the number recorded in 1903. It will be seen from the table that the corrected figure for the year 1892, the lowest year prior to 1903, was 130 in excess of the number recorded in 1903.

Any cause of enteric fever operates not only by causing notified cases which are directly due to it, and secondary cases due to the latter, but also gives rise to unrecognised cases which in their turn must cause other cases, some of which are recognised and notified, and some unrecognised. In other words the cessation of operation of a condition giving rise to a comparatively small number of notified cases which can be directly attributed to it would probably effect a still larger reduction of the total cases which occur.

The nature of the evidence bearing on the relationship between the shell fish eating and the subsequent attack of enteric fever, does not, in the large majority of the cases, go beyond the fact that shell fish was eaten between 7 and 21 days of the onset of the illness. In many cases, however, the sufferer is known to have eaten shell fish at Southend, where local evidence has to be taken into consideration. Some of the Westminster cases followed particular excursions, including a large number of persons to Southend, but it was impossible for Dr. Allan, the medical officer of health, to ascertain the facts generally as to the whole of the persons included in the excursions. The evidence in respect of these excursions is to the effect that certain people who were found to be attacked had eaten shell fish which always included cockles, and were in most cases limited to cockles.

On 8th November the Westminster City Council wrote to the London County Council referring to the cases of enteric fever which had occurred in Westminster last year, and "which upon investigation were proved to have been due to the fact that the patients had previously eaten shell fish from sewage polluted waters," and stating that the city council was of opinion that the laying down of all edible forms of shell fish in sewage polluted creeks or other dangerous localities should be prohibited by law under heavy penalties, and that all unpolluted layings, fattening beds, storage beds and storage ponds should be protected by law from pollution by sewage by any person or sanitary authority. A similar letter was sent to the Local Government Board and the metropolitan borough councils.

The London County Council has since received letters expressing the same opinion from the Sanitary Institute

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and 21 metropolitan borough councils, while one borough council has stated that it is in favour of all reasonable precautions being taken to prevent pollution of shell fish beds by sewage, and would suggest legislation in that direction.

In 1898 the council joined in a deputation from the authorities of 27 large towns to the President of the Local Government Board which urged the necessity of legislation in order to minimise the dangers to which the public are exposed through the consumption of sewage-contaminated oysters and other shell fish without however committing itself to the particular lines which such legislation should follow.

On 3rd February, 1903, the Council adopted the following resolution:—

> That a letter be addressed to the Local Government Board expressing the Council's hope that in the interests of the public health, the Board will, as soon as possible, take steps to obtain an amendment of the law, so as to prohibit under heavy penalties the laying down of all edible forms of shell fish in sewage polluted creeks or other dangerous localities, and the sale of such shell fish for human consumption; and that all unpolluted layings, fattening beds and storage ponds at present in use may be protected from pollution by sewage by any person or sanitary authority.

Statutory control should, I think, be exercised to prevent the taking for immediate supply for human food of any shell fish exposed to contamination to an extent which is deemed to make them dangerous to the consumer.

All layings for shell fish of any kind should be required to be registered, *i.e.*, it should be obligatory on the person carrying on the trade to give notice to a local controlling authority of the use of the laying.

The local controlling authority should inquire as to the risk of exposure of the layings to pollution, and should license for some fixed period the layings which it is of opinion are free from risk of dangerous pollution. Without such license it should be made illegal to take shell fish for immediate use or sale for human food. Shell fish from unlicensed layings should be permitted to be transferred to other layings approved by the local controlling authority, and after deposit therein for some minimum period, to be determined by a central authority, might then be permitted to be used for human food.

With respect to shores from which the public gathers shell fish, the local controlling authority should consider whether the shell fish are exposed to dangerous pollution, and should indicate by public notice the extent of area of any shore the shell fish on which should not be taken for immediate human consumption, and the taking of shell fish within these limits for immediate use as human food should then be prohibited; but collection might be permitted of such shell fish to be subsequently deposited for the prescribed period in a laying approved by the local controlling authority.

With respect to the question what should be the local authorities entrusted with this duty, I think it is desirable that they should be authorities having control over large areas. The River Boards mentioned in the third report of the Royal Commission are, I think, those best fitted for the purpose. It would be well to provide that the River Boards should receive information of any infringement of the law from the Sea Fisheries Boards and the Sanitary Authorities in whose areas the layings and shores are situated, and that it should be obligatory on these authorities to supply such information. The River Boards should not rely solely upon this information, but through their officers they should make inspections from time to time with a view to ensure compliance with the law.

The central authority might well be the new central authority mentioned by the Royal Commission in their third report.

I do not think there should be difficulty in dealing effectually with layings which are obviously subject to considerable pollutions, and subsequent knowledge and experience would guide as to the extent of necessity for interference with layings subject to less pollution.

In the event of refusal of the local controlling authority to grant a license, it would be well to provide for appeal to the central authority.

If by any specific act of an authority or a person owning sewers, subsequent to the licensing of a laying, the laying should become unfit for use, I presume the person prejudiced would be entitled to compensation.

I assume that power will be obtained to prohibit from admission into this country from abroad shell fish which is not known to come from layings which would be licensed in this country, except under the conditions that are required for shell fish taken from polluted layings in this country.

(Signed) SHIRLEY F. MURPHY,
Medical Officer of Health.

Public Health Department,
1st July, 1903.

18863. I am glad to notice that in your statement you approve of the suggestions that we have made in our third Report, both for the establishment of large Rivers Boards and of the Central Authority in London?—Yes; I think they are very good.

18864. Of course, if there is any further statement you would wish to put in you will do so?—Yes.

18865. (*Sir Michael Foster.*) I see you exclude the replies from five districts. Might I ask what led you to do that?—The information which I got from those districts did not satisfy me that the answers betokened sufficient inquiry to enable them to be regarded as in anyway comprehensive or inclusive.

18866. That means that you had really carefully estimated the value of the districts from which you did accept the evidence?—Yes. As matter of fact, in these districts—I think I may say nearly all of them—the returns were that they had not observed any cases of typhoid fever in which the patient had, antecedent to the illness, eaten shell fish, and I thought the results sufficiently improbable to make it better to exclude them from a numerical statement.

18867. I see that Dr. Hamer did make some inquiries as to the number of people eating shell fish in his district?—Dr. Hamer was inquiring into a localised outbreak of typhoid fever for the London County Council, and it became necessary for him to learn what the food supplies of the people in the locality were, and he included a table in his report on the causation of that outbreak, from which I was able to abstract the information which I have included in my own statement. I am sure that any inquiry made in London as to the proportion of the population which eat shell fish would show that this proportion varies very greatly in different localities.

18868. Varies in time or in locality?—In locality; it varies according to the class of person inhabiting the locality. Dr. Hamer's inquiry was into typhoid fever in a part of Southwark where there are numbers of working people who I know do eat—I can state that from my own observation—shell fish much more largely than people living in better circumstances. They eat mussels and they eat cockles, and they eat periwinkles, and so on, and the better to do people rather limit their shell fish eating, on the whole, to oysters.

18869. Do you think it would be practicable to have a census of the shell fish eating portion of the population. We have had before us such very divergent statements as to what is the proportion of people who eat oysters and other shell fish, and it is a valuable datum, is it not, not only for this but for other matters?—I think it would be quite practicable to take selected areas in a population like that of London. Of course, it would be too much to inquire throughout the whole of it, but it would be quite possible to take selected areas and to inquire. I have always found people very ready to supply information when it is for a useful public purpose.

18870. Do you think your Council would be willing to undertake that?—I do not see why they should not, they are always very pleased to do anything to obtain useful information.

18871. It would be quite a useful datum for us if we could have a tolerably accurate census, as Dr. Shirley Murphy suggests, of certain areas?—It would be.

18872. (*Colonel Harding.*) The only reliable datum?—The only reliable datum.

(*Sir Michael Foster.*) The only reliable datum.

18873. (*Colonel Harding.*) It rather seems so to me. you give in this paper the proportion of cases of enteric which are ascribed to shell fish as 8·4, and various estimates are given for the proportion of shell fish eaters. as something like that—one knows that these opinions were not based upon very accurate observation, but there it is, and if the proportion of shell fish eaters does

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not give a larger proportion of enteric than those who are not shell fish eaters, I do not think we can gather very much as to the evils of shell fish eating?—There is no doubt that that question underlies very much of the whole story of what shell fish does. I think it would be practicable, as Sir Michael Foster suggests, to take areas in well-to-do London and in poor London, and to enable some rough estimate to be formed—it could not be anything more than that—of what the shell fish eating habit of the population is. Of course, there is another question that I found somewhat difficult to deal with in connection with the subject, and that is this, that there are some people whom I may call habitual shell fish eaters, and there are other persons who only eat shell fish occasionally, and, I think, it would be necessary to distinguish between those. I take it, more or less, that all of us eat shell fish, perhaps, a few times during the year, but the habit of poor people, in some districts at any rate, is to eat shell fish quite regularly. For instance, the inspectors of the County Council made inquiry for me as to shell fish eating, and they ascertained that it was a very frequent rule among certain classes of the population to eat shell fish on the Saturday. I suppose the wages are recived on the Saturday or on the Friday, and a proportion of those wages seems to be spent almost regularly by some people in the purchase of shell fish. Those, of course, are people whom I should call regular shell fish eaters; and then there are others, as I say, who only eat occasionally.

18874. (*Sir Michael Foster.*) In the cases, reports of which you have received from the medical officers, are you trusting to their opinion that the causes were due to eating shell fish, or to your own judgment of the evidence which they made known to you?—I may say the figures are based simply upon cases—at least a large number of them—concerning which the only fact ascertained was that the people had eaten shell fish shortly before attack by enteric fever, and I could not put those figures forward as representing the views of the medical officers who supply them or my own, that the shell fish caused the disease; indeed one medical officer was shy of supplying me the information in case it might be mis interpreted.

18875. Have you formed any opinion yourself as to the amount of evidence which would satisfy you as to oyster or other shell fish being the cause of a clear case, say, of enteric fever?—I think it might be approached in this way. If in a family, say, one or two persons only had eaten shell fish, and the rest had not eaten it, and the attack of enteric fever is limited to the one or two persons who had eaten it, and this is repeated several times, then I should attach importance to that as a cause.

18876. Taking any notice of the interval which has elapsed between the eating of the shell fish and the occurrence of the disease?—Undoubtedly. I have here a little diagram based upon 253 cases in which the persons attacked by enteric fever had eaten shell fish shortly before attack, and in 146 of which I have precise particulars as to interval, 127 occurred not less than seven days and not more than 21 days before the illness.

18877. So that these results are results of the sequence of enteric fever after eating shell fish within the periods you mention?—Yes. The large majority of them if judged by the sample of which I have precise particulars.

18878. Nothing more?—In the majority of the cases that is so.

18879. That is the meaning, in fact?—That is the meaning of it. I have a diagram here which shows the periods which elapsed between the eating of the shell fish meal and the attack of enteric fever in the 146 cases previously mentioned. (*Diagram* II.)

18880. Would you put that diagram in?—With pleasure.

18881. Could you explain it?—This a diagram showing the number of cases in which the onset of illness occurred one, two, three, four, or more days after eating shell fish, as a percentage of the total cases in connection with which precise information on this point was obtained. The red figure at the top of each vertical column indicates the actual number of cases, and the height of the vertical column represents these figures as a percentage of the total cases.

18882. Of the pink column?—Namely, 146. That is to say, that in 146 of the total cases I get precise dates, and where I get precise dates these columns show whether they were in the first week, the second week, the third week, or the fourth week. It will be seen that the great bulk of them occurred within the second and third week.

18883. Shell fish from Southend we have reason to believe are suspected of being contaminated, or in certain cases are known to be contaminated?—Yes.

18884. Was that worked out at all in the other cases? Did your medical officers give you any information as to whether shell fish eaten, oysters or other, came from places which were under suspicion?—Yes, I have that information with respect to a number of the cases on a tabular statement here. That I think will show where I was able to get the information as to the source of the shell fish. It is this table. You will observe that the greater number of those for which this information was available had eaten shell fish at Southend or Leigh, or the shell fish were known to come from Southend or Leigh.

18885. 75, yes, but omitting these there is one case of cockles, from Margate, and one case from Dublin; as to the others, there are three mussels from Southwick, and two from Holland; but the oysters seem to be distributed over a large number of places?—Yes, there is no doubt that London cockle eaters who have had typhoid fever, and for which the source is known, ate Southend or Leigh cockles either there or in London.

18886. Is this where the shell fish come from or where they were eaten?—It is both. In a very large number of these Southend or Leigh cases the cockles were actually eaten at Southend or Leigh. I have here a diagram (Diagram III.) which enables a distinction to be made between Southend cases and cases in which the shell fish was not associated with Southend so far as we know other cases. This diagram shows cases which were associated with shell fish eating, per cent. of the total cases of enteric fever in London during each month. By London I may say that I am excluding my five districts again, so as to make the figures consistent throughout, so

CASES where Origin of Shellfish is stated.

Origin of Shellfish.	Cockles.	Oysters.	Mussels.	Other Shellfish.
Southend or Leigh - - - - - - -	75 One of these also ate mussels.	1	—	1*
Southsea - - - - - - - - -	—	1	—	—
Southwick - - - - - - - -	—	—	3†	—
Poole - - - - - - - -	—	1	—	—
St. Aubins, Jersey - - - - - - -	—	1	—	—
Margate - - - - - - - - -	1	—	—	—
Holland - - - - - - - -	—	—	2	—

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CASES where Origin of Shellfish is unknown, but patient stated to have eaten Shellfish at places outside London.

Places where Shellfish was eaten.	Cockles.	Oysters.	Mussels.	Other Shell fish.
Whitstable	—	1	—	—
Sheerness	—	1	—	—
Southend	—	6	—	6
Folkestone	—	1	—	—
Plymouth	—	1	—	—
Littlehampton	—	1*	—	—
Ramsgate	—	1	—	—
Dublin	1	—	—	—
Westgate	—	1	—	—
Margate	—	2‡	—	—
Brighton	—	4	—	—
Southampton	—	1	—	—
Blackpool	—	1	—	—
Yarmouth	—	1	—	—
Reading	—	1	—	—
Hastings	—	1	—	—

* Winkles also from Isle of Muck, Scotland. † Also ate cockles. ‡ Also mussels.

that my London to-day for this purpose is really minus five districts, and has a population of somewhere about 3,500,000 persons.

18887. Within such periods as is consistent with the shell fish having been the cause of the fever?—With very few exceptions, if I may assume that the cases of which the period between shell fish eating and attack by typhoid is definitely known are a fair sample of the whole. In January the proportion of shell fish cases to total cases was nearly 4 per cent. In February it was rather more than 5. It fell in February to about 2 per cent. It showed a marked increase in July, which is, of course, the beginning of the summer holidays, when it had reached very nearly 12 per cent., and then the next month, August, it was nearly 10 per cent.; in September it was 23 per cent., and after that it fell in October to 9 per cent.; November rather more than 5 per cent., and December nearly 11 per cent. This diagram shows the cases that are known to be associated with Southend, and with Southend I include Leigh. I have no information that cases associated with Southend or Leigh shell fish occurred until June, when between 1 and 2 per cent. of the total typhoid of London——

18888. Excuse me for one moment; do they eat Southend cockles only when they go to Southend; do they not eat cockles all the year round?—I am told this is so.

18889. Do not cockles come from Southend all the year round?—I have learned shell fish are sold about London streets all the year round, and the officers making the inquiry were told that Southend and Leigh cockles were received at all times of the year.

18890. Then in spite of Southend cockles being distributed and eaten in London during those first months, no cases whatever could be attributed to them?—Yes, this was so, so far as my information goes. The Southend cases occurred in June, in July, in August, in September, in October, and in December. Of course, in August particularly large numbers of people go to Southend and eat shell fish there, so that the proportion which you were seeking to learn just now has to be considered in relation to probably the increased number of the population eating shell fish in that month. I suppose that the cockle is looked upon as a holiday luxury by some people, and I imagine that a good deal more Southend cockles would be eaten at that time than probably at other times of the year.

18891. Would you go so far as to say that the amount of Southend cockles which are eaten in London during the winter months may be neglected?—No, I should not like to make any such assumption as that; of course, I am dealing here with a particular year (1902), and I have reason for thinking of Southend and Leigh cockles as being mischievous in 1902 in a much larger way than perhaps before that.

18892. On account of the occurrence of enteric fever at Southend itself?—Yes, on account of the occurrence of enteric fever at Southend itself, and also in Leigh.

18893. There was an epidemic more or less then?—There was.

18894. Do you remember when that began?—I think I have that here. Dr. Nash, the medical officer of Southend, has a table in a report of his on the subject, and the first case in association with cockles is put down as June 3rd, but then that table only relates to cases in June and July.

18895. I forget now, we have had that report, whether he gives the total number of cases of enteric fever in the district?—I have a diagram showing enteric fever in Southend. This diagram (Diagram IV.) shows for each week of the year the number of cases of enteric fever in Southend.

18896. Which is 1902?—This is 1902, and these are the actual cases.

18897. It began to be abundant in June?—It began to be abundant in June. There were cases in the early part of the year, but not much; it was substantially in June that the Southend outbreak began, so that that diagram really is fairly consistent in point of time with the beginning of the occurrence of cases in London associated with the eating of Southend shell fish.

18898. Taking all your cases together, and viewing them with as critical a spirit as you possibly can, they still leave on your mind the conclusion that there is some connection between the enteric fever and the eating of the shell fish?—Yes, undoubtedly, and especially with regard to Southend.

18899. Then excluding Southend; supposing we were to exclude all the Southend cases, would you say that there was any at all trustworthy evidence in your figures that there is a connection between eating any kind of shell fish and enteric fever in London?—I do not think it is conclusive evidence; I think it raises a strong suspicion, but I do not think it goes beyond that.

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18900. But it goes so far, in your opinion, as to raise a suspicion?—Yes; but I have not precise figures, and cannot lay more stress upon it than to say it creates in my mind suspicion.

18901. You consider the desirability of having some statistics as to the shell fish eating position of the population?—Yes, I admit at once that it would be most valuable to have that.

18902. I suppose you have had brought before you on a good many occasions what you have yourself deemed unsatisfactory evidence as to the connection in this case or that between the eating of the shell fish and the enteric fever?—Yes; I do not think that one can assume, because so many people who have suffered from enteric fever have eaten a particular article of food before their attack that the illness is necessarily due to that particular food. I think one is bound to take into consideration what proportion of the population are shell fish eaters.

18903. Is it too much to ask you to state your view of what you consider to be the main outlines of satisfactory evidence, and what are the features of what you consider unsatisfactory evidence?—I think if one could find, examining households in which a case of enteric fever has occurred, that there are two groups of persons, one of which had eaten shell fish and the other had not, that in house after house one found that the incidence of the disease was on the shell fish eaters, I should attach very considerable importance to that, and I should look upon that as evidence.

18904. Evidence accumulating as the numbers increase?—Evidence accumulating as the numbers increase, but if I only had the bare figure that out of, say, 1,000 cases of enteric fever, so many of them had eaten shell fish before, I should say that was unsatisfactory evidence; it did not go far enough.

18905. I see in the statement you have placed before us you put a warning against receiving a certain increase in a particular time as due to shell fish, the fact that at that time there were floods in the Thames?—Yes.

18906. I suppose one may have several possible concomitant causes of enteric fever with the occurrence of the eating of shell fish?—That might be so undoubtedly. I had the duty of inquiring into enteric fever in 1894 after floods, and I think there the evidence came out fairly strongly that the flood water had given rise to enteric fever in the London population.

18907. You were able, I suppose, to trace the chain of evidence there in several cases?—The evidence consisted of several circumstances that pointed to that conclusion.

18908. It is not merely the concurrence of the floods with the occurrence of enteric fever, but you could connect the cases with the effects of the flood?—I was dealing with it entirely numerically, and found an increase in the number of cases corresponding with the floods in point of time. There were also several other circumstances that pointed to the water supply as a cause.

18909. Yes; what other circumstances?—The district supplied by the London water companies outside London manifested an increase at the time that corresponded with the increase in London, and the districts otherwise supplied, taking a certain area round London, did not manifest that increase. One water company had less storage capacity than other companies, so that the water was used almost directly, and the increase in the number of cases occurring in the population supplied by that water company occurred a week earlier than the others.

18910. So there you had to a certain extent drawn out the chain of evidence?—I think so.

18911. You were not trusting simply to bare numerical results?—No; we had additional evidence beyond that.

18912. Do you think the consumption of shell fish during the past year in London, or at all events during the past six months, say, has been very much less than it was previously, owing to the scare?—I have had inquiry made by the Council's inspectors from persons selling in the streets, and I think the general impression was that that was so. At Woolwich I myself saw in a public place a cautionary notice signed by the Medical Officer of Health of the district cautioning people not to eat shell fish from polluted sources.

18913. Do you think that has been accompanied by any noticeable diminution in the enteric fever?—There is no doubt that there has been very much less enteric fever during the present year.

18914. That is your table; you have given us that in a table?—Yes, and I have it also in more detail, month by month.

18915. Have you the monthly result from the end of 1902 up to, say, March or April in the present year?—Yes; I think I have that on a table here.

ENTERIC FEVER (NOTIFIED CASES, 1903).

Weeks.	1890.		1891.		1892.		1893.		1894.		1895.		1896.	
1—4	149	*164*	161	*176*	131	*142*	197	*211*	192	*204*	365	*384*	253	*264*
5—8	88	*97*	158	*173*	105	*113*	175	*187*	225	*238*	149	*157*	233	*243*
9—12	137	*151*	217	*237*	100	*108*	146	*156*	194	*206*	121	*127*	140	*146*
13—16	111	*123*	161	*176*	108	*117*	143	*153*	171	*181*	112	*118*	137	*143*
17—20	95	*105*	189	*206*	125	*135*	179	*192*	161	*171*	186	*195*	188	*196*
21—24	145	*160*	154	*168*	151	*163*	190	*203*	181	*192*	238	*250*	143	*150*
1—24	725	*800*	1,040	*1,136*	720	*778*	1,030	*1,102*	1,124	*1,192*	1,171	*1,231*	1,094	*1,142*

Weeks.	1897.		1898.		1899.		1900.		1901.		1902.		1903.	Mean, 1890–1902.
1—4	203	*211*	181	*187*	308	*316*	381	*390*	318	*323*	176	*177*	*174*	242
5—8	198	*205*	129	*133*	280	*288*	309	*316*	223	*226*	162	*163*	*126*	195
9—12	165	*172*	140	*144*	175	*180*	275	*281*	154	*156*	149	*150*	*107*	170
13—16	133	*138*	120	*124*	120	*123*	221	*226*	115	*117*	101	*102*	*68*	142
17—20	119	*124*	105	*108*	122	*125*	186	*190*	121	*123*	173	*174*	*72*	157
21—24	170	*176*	115	*119*	147	*151*	219	*224*	155	*157*	212	*214*	*101*	179
1—24	989	*1,026*	790	*815*	1,152	*1,183*	1,591	*1,627*	1,086	*1,102*	973	*980*	*648*	1,086

Notifications (first column under Years).
Corrected for populations in *italics*.

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18916. Would you read those out, beginning at, say, November or December of 1902?—In 1902 during the first four weeks of the year there were 177 cases notified; in 1903 there were 174. In the next four weeks, from the fifth to the eighth week—I am giving you figures corrected for increased population, so they are not the actual cases, but they are corrected for increased population—there were in 1902, 163 cases; in 1903, 126.

18917. You say corrected for population; these are actual notifications, are they not?—No; I have allowed for increase of population. The population I am taking in 1903 is a little bigger than 1902.

18918. But these are actual notified cases—the number of notified cases; they have not any relation to population?—I must make myself clear. I had this prepared for a series of four weeks in the early part of every year since we have had notification, from 1890 to 1903. I have taken the population of 1903, which of course is a good deal more than the population of 1890, and have increased the number of cases of enteric fever to raise them to what they would have been had we in the earlier years had the same population that we have now, so that I can give them to you in actual cases or corrected in this sense. But perhaps it would be just as well that I should give the actual number of cases notified between 1902 and 1903; as the increase of population is very trifling in a year, so that it is 176 in 1902 as against 174 in 1903.

18919. Which weeks are those?—The first four weeks; and in the second four weeks 162 as against 126, so that it is in the second four weeks that the fall commences. In the third four weeks, 149 as against 107.

18920. Is not that unusual to have so large a number in the first four weeks of the year?—No.

18921. It widens as you proceed during the year?—The numbers generally decrease until April, after which they gradually increase.

18922. It is the normal course?—It is the normal course. Then the fourth four weeks it was 101 as against 68, and the fifth four weeks 173 as against 72, and in the sixth four weeks 212 as against 101, so that in this period of the first 24 weeks of the year in 1902 there were 973 cases notified; in 1903 there were 648.

18923. The great diminution you mean after the first eight weeks practically. Will you begin the second four weeks?—The second four weeks shows some fall, but it is after that that the difference between the figures for the two years becomes more marked. I may say that, taking the 14 years 1890 to 1903, or rather the 13 years 1890 to 1902, the 648 cases that we have had within the last 24 weeks is far smaller than we have had in any previous corresponding 24 weeks.

18924. Has the scare had any effect by leading to the diminution of the eating of oysters; that did not become apparent until some time after?—I am not able to say when the scare occurred.

18925. It occurred early in the year, did it not; it occurred at Christmas, did it not?—Yes, I think it was about Christmas time that there was very much talk about shell fish and enteric fever.

18926. But the effect of that is very rapid, is it not? For instance, a man reads an account in the paper, and forthwith abjures all oysters and shell fish, and the people in the street learn it very rapidly?—I find it quite impossible really to state whether there has been a scare affecting the population. I can only say this——

18927. Well, one would naturally expect that if the scare led to the diminution of eating oysters, and the diminution of eating oysters, by doing away with the possible source of enteric fever, diminished the enteric fever, the diminution would make itself felt very soon after, the scare would very rapidly reach a maximum, and then as men began to think less about it it would diminish afterwards, whereas this is the contrary here?—If we assume that the scare occurred at the end of the year.

18928. (*Colonel Harding.*) The outbreak at Winchester occurred on the 10th of November?—One must allow an incubation period of a week or 10 days for the disease to develop, so that you have got a month's time—the best part of a month's time—for the scare to operate in reducing the actual notifications.

(*Sir Michael Foster.*) Yes, but still it was on the 10th of November.

(*Colonel Harding.*) So it is stated in this document.

18929. (*Sir Michael Foster.*) It was on the 10th of November, and the scare was most vehement in December?—Yes.

18930. It has produced no effect apparently in the first four weeks of January?—Yes.

18931. And then instead of increasing, if it were effectual, it has diminished?—Yes, that is so.

18932. We must assume that the effects on people's minds were permanent and were growing?—That they were growing, if we are to associate the diminution of enteric fever with it. I may say I tried to learn whether there was any actual falling off in the amount of shell fish that entered London, and I went to the clerk of the Fishmongers' Company. Unfortunately he was not able to supply me with the figures that I could draw any safe deductions from. He was good enough to give me the amount of fish that entered the markets.

18933. Shell fish?—No; it was to get the actual figures in shell fish that was my difficulty, and the Chief Inspector of the Billingsgate Market called upon me and told me I might presume 25 per cent. of that was shell fish. The actual figures are shown in this table.

18934. Yes, it is in rather a roundabout way, is it not?—Yes. I was not prepared myself to draw any conclusion from it.

18935. Passing on to your views about the administration, in which you express your approval of the recommendations shadowed forth in our third report, you speak, the last paragraph, of the local controlling authority; you mean the larger local authority, corresponding to Rivers Boards?—Quite so, as distinguished from the central Board.

18936. Quite so, or as distinct from Rural Districts Sanitary Authority?—Yes, I used the words "local controlling authority" because they are not Sanitary Authorities, and they are not County Councils.

18937. No, of course, the Rivers Board would be, in the main, a Sanitary Authority, would they not?—It would consist——

18938. I mean its object would be in the main sanitary?—Oh, yes, its functions would be sanitary, undoubtedly.

18939. But you think the authority should rest with them, but that the authority should be in relation to the Fisheries Committees?—I think the Fisheries Committees might very well give them notice as to the occurrences that came under their observation.

18940. You remember, doubtless, it was in 1899, was it not, the Bill concerning oysters which was brought before the House of Lords, and fell through on account of the proposal in the Bill that the Sanitary Authority should be the judging authority, was changed by the Committee of the House of Lords into the Fisheries Committee?—I remember the circumstance quite well.

18941. And you are of opinion that it should be an authority sanitary in functions, and not a Fishery Committee?—Oh, absolutely.

18942. Which should have control of these matters?—Certainly.

18943. (*Major-General Carey.*) What would be your expectation of finding enteric fever which could be attributed to shell fish, if the places at which there is obviously pollution are properly dealt with?—I think that if the places where there was obvious pollution were properly dealt with, any enteric fever that occurred in London from shell fish would form such a small proportion of the total cases that it would not be practicable to discover it. I do not say that we might not get an occasional case occurring, but that it would be lost in the total number of cases of enteric fever. It would in no sense be conspicuous. It is very difficult, of course, to make a forecast, but the impression I have formed is that it is the dealing with the obvious local pollutions which is essentially required.

18944. Have you any information as to the source from which the bulk of the shell fish are obtained which are consumed at Southend?—I know that large numbers of them come from Leigh. I went to Leigh this year, and was told that large numbers of them came from that source.

18945. That is including cockles?—Especially cockles, yes.

18946. Are not a large proportion of cockles taken from the Maplin Sands?—There is no doubt a number taken from the Maplin Sands to begin with.

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18947. And do you consider that these cockles are liable to pollution, say, from Southend or from Shoeburyness?—I cannot claim any detailed knowledge of the local circumstances, but it occurs to me that Maplin Sands are not very far off from Shoeburyness, and that pollutions might arise from that source.

18948. That district would not come within the jurisdiction of the London County Council?—No; it is entirely outside it.

18949. (*Sir Michael Foster.*) You studied, I suppose, the discharge of the Thames sewage outwards from Barking?—I have some general knowledge of it; I have not made any precise or detailed inquiry about it.

18950. Have you formed any opinion as to how long it would take for, say, the bacillus typhosus if it survived to reach the Nore from Barking?—All the information I have upon it is that contained in the First Report of the Sewage Commission.

18951. You mean this paragraph:—

"83. First as to tidal oscillation. When Mr. Frank Foster was making his early designs in 1850-1, in order to judge as to the position of his outfalls, he directed some experiments to be made to ascertain the nature of the tidal currents in the river. These experiments were carried out by Mr. Phillips, who has described them in his evidence (Q. 6357, *et. seq.*)

"Floats were put into the river at Barking Creek (the supposed point of outfall) at different times of tide, and their positions noted at the extremes of their motion. The general result was to show: First, that the tidal oscillation varied from about 10 to 14 miles in length; secondly, that when the float started from Barking after high water it was carried by the next flood tide considerably above Barking; and, thirdly, that the permanent progression down stream did not exceed five miles in 15 days, *i.e.*, on the average, one-third of a mile per diem. As a deduction from the experiments it was stated:—

> "That if the sewage be not put into the Thames at Barking Creek at some period earlier than two hours after high water, each tide there will always be the certainty of its going up the river as far as Greenwich; and should a long continuation of northerly winds happen just after the times of lowest neaps, there is every probability of its being drawn up as far as Rotherhithe.

"Sir John Bazalgette, in his evidence before this Commission, refers to these tidal experiments. He gives (Q. 5) 12 miles as the extent of the tidal oscillation; and he says (Q. 86): 'It may be roughly assumed that a substance in suspension works up the river about one mile a day at each high water, as the spring strengthens, and down the river two miles a day as they fall off.' But he does not consider that the motion of a float is analogous to what would take place with the particles of sewage.

"Five years later these experiments were checked, at the request of the First Commissioner of Works, by Captain Burstal, who has given the Commission an account of his experiments and his report upon them. (Q. 6485 to 6500, and Appendices C and L.) He confirmed the accuracy of Mr. Frank Foster's experiments, and added some data as to the set and velocity of the streams and currents in that part of the river, showing that certain circumstances connected with them were favourable to the deposit of matters in suspension.

"Captain Burstal also adds (Q. 6427 and 6500) further experiments on the set of the tides.

"In 1857 the Government referees, Messrs. Galton, Simpson, and Blackwell, referred to the experiments of Mr. Frank Foster and Captain Burstal, and to some further float trials made by Mr. Homfray. The conclusions they drew on the subject have been given in the Historical Notice.

"A large series of float experiments, made expressly for production before this Commission, are described in the evidence of Messrs. Baldwin, Latham, and Birch, and graphically delineated in the drawings, Appendix T. A special description is also given in Mr. Latham's report, Appendix R.

"Seven distinct sets of observations were made, with large floats specially constructed for the purpose. These floats were put into the river, opposite the northern outfall, at various periods of the tide, and each float was carefully watched, and its motions and positions were accurately recorded for many days; some were observed for 45 days, other for more than 30 days, and one for 18 days, all therefore giving a range over both springs and neaps.

"There are many anomalous circumstances in the recorded motion of the floats, arising probably from wind, or irregularities in the currents, or other accidental causes; but there is not a doubt of their good faith, and as a whole they bear evidence of trustworthiness, and may be considered as representing what they profess to represent, namely, the actual motion of some portions of water of the river, in the neighbourhood of the northern outfall, under different tidal conditions. And the rough practical inference may be undoubtedly drawn from the experiments, that where the floats went, sewage discharged from the outfall at the same times of the tide may also go.

"The chief points shown by these experiments are briefly as follows:—

"1. The extent of the tidal oscillation varied considerably, the variation being due not only to the character of the tide, but also probably to the position any particular float happened to occupy in the river, some parts of which move faster than others.

"2. The maximum range of oscillation recorded at spring tides was about 18 miles, the minimum at neap tides a little under seven miles; the mean of the whole of the observations gave about $12\frac{1}{2}$ miles.

"3. A float which was started from the northern outfall at high water is said to have ascended, with subsequent flowing tides, to a distance of seven or eight miles above the outfall, or to Greenwich.

"4. Another float which was started from the northern outfall three hours after high water is said to have ascended, with subsequent flowing tides, to a distance of 20 miles above, or between Putney and Hammersmith bridges.

"5. Another float which was started from the northern outfall at low water is said to have ascended, with subsequent flowing tides, to a distance of 21 or 22 miles above, or between Hammersmith and Chiswick.

"The general result of these experiments accord fairly with those formerly obtained, so far as the length of the daily tidal oscillation is concerned, and they add important and novel information as to the distance to which tidal currents may travel. For it is now evident that, at whatever time of tide the sewage is discharged, some of it may, under certain conditions, be carried up by the tidal oscillation alone into the heart of the metropolis, and even further"?—Yes.

18952. Well, what conclusion do you think might be drawn from that statement there?—I should think it is very doubtful indeed whether sewage after that length of time would have any effect at all—any injurious effect upon shell fish.

18953. You mean that the bacillus typhosus would be killed in the interval?—I should not expect it to be operative after such an interval of time as is indicated there.

18954. And the other organisms too; would the sewage be sterilised, do you think, by the journey?—I should think probably very largely. I must say at once that I do not pretend to speak as a bacteriologist.

18955. (*Major-General Carey.*) Have you any suggestion to make with regard to the control of oysters and other shell fish introduced into this country from abroad?—I think this—that if the legislature applies to the shell fish trade in this country restrictive conditions for the safety of the population, any shell fish coming from abroad ought to be subject to the same conditions, not less.

18956. Would you regard the control of the foreign shell fish as a necessary part of any adequate preventive measures?—I think certainly they should be included.

18957. In your statement you say that under certain circumstances you presume the person prejudiced would be entitled to compensation: "That if by any specific act of an authority or a person owning sewers, subsequent to the licensing of a laying, the laying should become unfit for use, I presume the person prejudiced would be entitled to compensation." Who would that compensation be paid by, do you think?—I take it, by the authority through whose action he is interfered with.

18958. Or by the individual, I presume, if it was a private sewer?—Or by the individual if it were a private sewer.

18959. And if pollution is caused by the sewers of a local authority which were laid previous to the laying, do you consider that any compensation should be paid?—No, not under those circumstances.

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18960. That the laying in fact must be removed from its position without compensation?—I think the laying must obviously be removed from its position. I should not myself have thought that compensation would be given under those circumstances.

18961. (*Mr. Stafford.*) What is the London death rate from enteric fever per 10,000?—Will you have it per 1,000.

18962. Per 1,000 if you have got it?—In 1901, which is the last figure I have, it was ·11; in 1900 it was ·16, and in the previous year, 1899, it was ·17.

18963. It is a small percentage?—It is a low death rate.

18964. This diagram here, (see Diagram V), which you have showed to the Commission, refers only to the shell fish enteric death rate, is not that so?—That is so.

18965. It is the death rate from enteric fever during particular months?—During particular months stated, as a proportion of the total enteric fever cases of that month.

18966. I take it from this that your increased death rate from enteric commenced about June, and went on in July and August, and reached its greatest height in September?—That is so.

18967. That would rather exclude, would it not, home oysters having anything to say to the increased death rate?—I think I could not distinguish between the oysters and other shell fish.

18968. No, but you see that in those months there is a close season for the home oyster?—Yes.

18969. So it practically excludes the home oyster from having anything whatever to say to the increase in the enteric fever?—Yes.

18970. So that the whole of this increase which you show here would be due either to foreign oysters or to other shell fish?—Yes, assuming that the home oysters are not upon the market then, which I take to be the case.

18971. But that is the case, is it not?—Yes; I forget exactly the close season.

18972. From April to September is the close season?—Yes.

18973. You cannot count that September increase as having anything to do with oysters?—No, but I think that increase is certainly substantially not home oysters.

18974. Except, of course, it may be due to foreign oysters relaid in English layings or coming in fresh?—Such information as I have about the shell fish consumed leads me to think that oysters play a secondary part to cockles. I think it is cockles that are eaten proportionately very much more largely, and, as we know, London was last year certainly supplied with cockles from a polluted source.

18975. You cannot give us any information which would show the total consumption of shell fish in London?—No, I am sorry to say I was not able to obtain that information.

18976. About the total consumption of shell fish?—Yes.

18977. And the proportions of the various shell fish consumed; that is the proportions of cockles and mussels compared with oysters?—No; I endeavoured to get that information from the Fishmongers' Company. Mr. Wrench Towse, the clerk, was good enough to say he would supply it if he possibly could, but he found it impossible to do so.

18978. It would be interesting to know what the total consumption of shell fish is?—Yes. I do not know whether by more prolonged search than has been made it would be possible to supply it. I mean if the Commission asked for it, it might perhaps be possible after a longer interval for the Fishmongers' Company to obtain this information.

18979. Do you think it is safe to make any deductions whatever with regard to patients who get enteric fever, say, from 7 to 12 days after they have consumed shell fish?—From the bare fact?

18980. From the bare fact?—I think from the bare fact it is not practicable without additional information to draw conclusions.

18981. In fact, you would practically exclude every other source before you would put those cases of enteric fever down to being due to shell fish?—All other probable causes should be considered, but one can never exclude all possibilities.

18982. No, you cannot, of course?—I think one is bound to assume a strong probability that shell fish are responsible for the disease after there has been a special incidence upon the shell fish eaters, whether in the population as a whole or in the particular homes that are invaded, and when other explanation is not forthcoming.

18983. Yes; well, you cannot say that, can you?—Is there any special incidence?—In particular cases that has been shown. For instance, in Wandsworth Dr. Caldwell Smith, the Medical Officer of Health, found, I think, two or three cases in one house, and I think, there had only been one other person beyond those attacked who had eaten shell fish. There he was able to make his comparison between the people who had eaten shell fish and those who had not. Then, with regard to Southend, a number of the cases that I have included in the Southend cases occurred, so I learn from Dr. F. J. Allan, the Medical Officer of Health of Westminster, after excursions to Southend. A large number of people went to Southend in these excursions, and a number of them ate cockles and some of them were attacked.

18984. But there was nothing to show generally that people who eat shell fish habitually are more prone to enteric fever than those who do not?—I am not able to supply London figures showing the incidence of enteric fever on the two populations, the one eating shell fish, the other not.

18985. Have you formed any opinion yourself as to the percentage of the cases in London caused by shell fish?—The information supplied to me by the medical officers of health from whom my information was got showed that 8 per cent. of the cases of enteric fever that occurred had eaten shell fish at a time before the attack that was consistent with it having been the cause.

18986. Those are the people who possibly may have got it, but have you formed any opinion as to what the proportion really is?—No. I have not been able to form anything like a precise idea.

18987. Because the figures given here are rather the possible figures?—That is so.

18988. Rather than the probable ones?—Yes.

18989. You can hardly say they are even probable?—No; I do not think it is possible really to make a definite statement in regard to it.

18990. The Commssion have been receiving in evidence statements from medical officers of seaside places to the effect in one instance that 50 per cent. of the total cases of enteric fever were due to shell fish?—Yes.

18991. And in other cases as high as 36 per cent., I think, was stated here. There is nothing in your figures in London to come anything near these figures?—No, but I may say this, that I think my London figures fall short of what they would be if we knew all the circumstances. The fact that the patient is very often removed to hospital before the medical officer of health comes upon the scene would lead, in some proportion of cases at any rate, to the knowledge being wanting, so that I think my 8 per cent. really falls short of the number that would have been obtained if full inquiries could have been made. Of course, I am not assuming that that number had actually got the disease from the shell fish.

18992. I understood from your reply to Sir Michael Foster that you do not consider that this reduction in 1903 was altogether due to the oyster scare or shell fish scare?—I am not satisfied that it actually caused the whole of it, but I must say I am impressed by this very low fall of enteric fever in London, and I suspect that some part of it may be due to less shell fish being eaten, but I do not see how it is going to be proved. There was a point in connection with that that you might like to have before you—that is, the age distribution of the persons attacked in the first 24 weeks of this year, as compared with the age distribution of the persons attacked in the corresponding period of last year.

18993. Yes?—The proportion of persons under 20 years of age attacked in 1903 was less than the proportion attacked in 1902, namely, 43·3 per cent., as against 48·1 per cent. in the previous year; it is the younger persons who, I think, are mostly the shell fish eaters, and that would be consistent with the diminution of a cause particularly affecting younger persons.

18994. Do you think it is the younger persons that eat shell fish chiefly?—I think it probably is. I am speaking now from observation of certain inspectors I asked to watch some of the stalls as to the class of people who purchased at the stalls, but, of course, it is not a precise statement.

18995. It strikes me as rather a novel fact that it is the younger people who eat shell fish, but you will observe in your figures that in 1900 there were 1,627 cases notified in the first 24 weeks, in 1901 there were 1,102, in 1902 there were 980, and in 1903 there were 648. Well, now, that is a steady decrease since 1900. You see there was a decrease in 1901; there is a further decrease in 1902, and then we get the largest decrease no doubt in 1903; but the decrease had commenced in 1901. You do not attribute that decrease to the oyster or to the shell fish scare?—Oh, no; there are great variations in typhoid fever.

18996. There always are very great variations?—Yes, probably with no relation to shell fish eating.

18997. But you think the variation and the great decrease in 1903 was somewhat anomalous?—It was quite anomalous. We have had nothing like it since the time we have had enteric fever notified in London.

18998. But in 1892, you see, you were down as low as 778?—Yes.

18999. But typhoid fever has got a habit of going up and going down in these peculiar ways?—Yes.

19000. And you cannot assume from the fact that you have only got 648 this year, that you may not be back to your 2,000 again, or over it, next year?—No, that is so.

19001. It is very hard to calculate in regard to typhoid fever as to how it will go up, and how it will go down?—Very hard.

19002. Is it quite safe then for you to assume that really any portion of this decrease in 1903 is due to the scare?—No. I could not draw a definite conclusion, but I mention it as a matter of interest in connection with the subject. For instance, taking the 12 preceding years, the lowest figure we have had in the 24 weeks, if we correct for population, as we must, going back that time——

19003. Is 815?—Is 815; 800 in 1890.

19004. There is 778 in 1892?—Yes, you are quite right, 778; yes, that is lowest in 1892.

19005. My point is that your decrease has commenced in 1901 and has gone steadily down?—Yes.

19006. And that decrease was not originated in the shape of anything in the nature of a scare with regard to shell fish?—No, that is so; I am not myself disposed to come to conclusions about the enteric prevalence; what I do notice here is that we have had a fall in two successive years, and in the last year we have had nothing so low as that in any of the preceding years.

19007. It would not surprise you next year to find it back at over 1,000 again?—No, not at all.

19008. In reply to General Carey, who asked you about layings being properly dealt with, would you tell us what you would consider properly dealing with a laying as regards sewage contamination?—I should examine particularly the physical circumstances with regard to shell fish layings, their proximity to sewer outfalls, the direction of currents, and so on, and I should also wish to have regard to such evidence of pollution as the bacteriologist and perhaps the chemist may afford; but very much in the main I should be guided by the physical circumstances, and certainly where there is evidence of pollution, such as may be found in Dr. Bulstrode's report, I should be perfectly satisfied that the sale of shell fish from such layings ought to be prohibited.

19009. Yes. Those are the grosser cases?—Those are the grosser cases.

19010. There will probably be some difficulty with regard to less gross cases. Would you lay down any bacteriological or chemical standard of purity?—I do not think I should at once; whether we may come to that later I am not at all prepared to say, but at any rate to begin with, I should not. It seems to me that if these River Boards got to work and brought to an end the existence of the obviously polluted layings, they would in the meantime, by studying the subject, have got further knowledge that might be applied perhaps to those that are less polluted. The thing would have to be done by degrees, though some of the layings, I take it, would at once go. With regard to others, it would be a matter for doubt as to how to proceed.

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19011. Would you let me put you a concrete case in regard to this map? Suppose that you had no pollution at Southend or Leigh, that you had merely to deal with the effluent from Barking and Crossness, do you think that you could lay oysters safely about Leigh and Southend?—I should not be prepared, with the knowledge I have, to say it was impossible to lay them there.

19012. Now what standard would you ask for there? Would it be a bacteriological standard? You know the composition of the effluent from Barking and Crossness, and what standard of purity would you require for laying oysters at Southend and Leigh?—Well, I do not think I should have a standard of purity for that. I went to Leigh; I saw the outfall from the sewage works in such close proximity to the layings of cockles, I had no difficulty about that.

19013. I am assuming that Leigh and Southend are treating their sewage perfectly, and I am dealing altogether with the effluent coming from Barking and Crossness. Would you under those circumstances, assuming there was no other pollution, consider that oysters might be laid at Leigh and Southend?—With such knowledge as I have at the present time I should not object to it.

19014. Quite so; but what standard, then, would you adopt? You would require some standard; from topography, from inspection, it seems all right; you would require some bacteriological standard or chemical standard?—I think you must ask the bacteriologists upon that point. I personally should hesitate very much to apply a standard there without knowing exactly what the effects of it are going to be as applied to England generally. I take it that if you apply a high standard you will practically prohibit the laying of shell fish in any way round the English coast.

19015. Yes, but that is eminently a case for a bacteriological or chemical standard?—Yes, if you can show that alongside with bacteriological and chemical standard you can get some clinical evidence of mischief arising from it.

19016. You would wait for some further evidence?—Yes; as I say, I do not profess to speak as a bacteriologist, but I do say this—that I should, at any rate in the earlier stages of any administration, propose to have regard rather to topographical circumstances than to any standard that could be given in that way.

19017. I asked you the question because I see here in your statement that the London County Council have been pressed by various bodies—the Sanitary Institute and 21 Metropolitan Borough Councils—to promote legislation with regard to this question of layings of shell fish, and you addressed a letter to the Local Government Board—the County Council did—"expressing the Council's hope that in the interests of the public health the Board will, as soon as possible, take steps to obtain an amendment of the law, so as to prohibit, under heavy penalties, the laying down of all edible forms of shell fish in sewage polluted creeks or other dangerous localities." The "other dangerous localities" and the "sewage polluted creeks," one wants to get some fixed idea of how much pollution. What is the standard of pollution?—I think that the proposed Central Board must study the subject very much further than it has yet been studied before it would be possible to arrive at anything like a standard of pollution that should determine the position of shell fish layings. I do not think that such a standard can now be stated, but what can be done and what I feel sure ought to be done, is the closure of such layings as have been specially pointed out in Dr. Bulstrode's report.

19018. So it is not quite so easy a matter as they seem to think to legislate with regard to all these questions of pollution and dangerous localities?—No doubt the layings that are on the border line would raise very difficult questions.

19019. I allow you, of course, a certain number would go out at once probably, but there would be very considerable difficulty of administration with regard to a great number of layings?—I think there will be difficulties of administration with regard to it, but that is a matter that must be made the subject of very careful investigation by the Central Board, and one hopes that knowledge will increase sufficiently to enable questions of that sort to be determined.

19020. You would wait before attempting to lay anything down in the shape of standards?—I should myself.

19021. (*Chairman.*) I only wanted to ask you whether you have any explanation of the great rise in the figure

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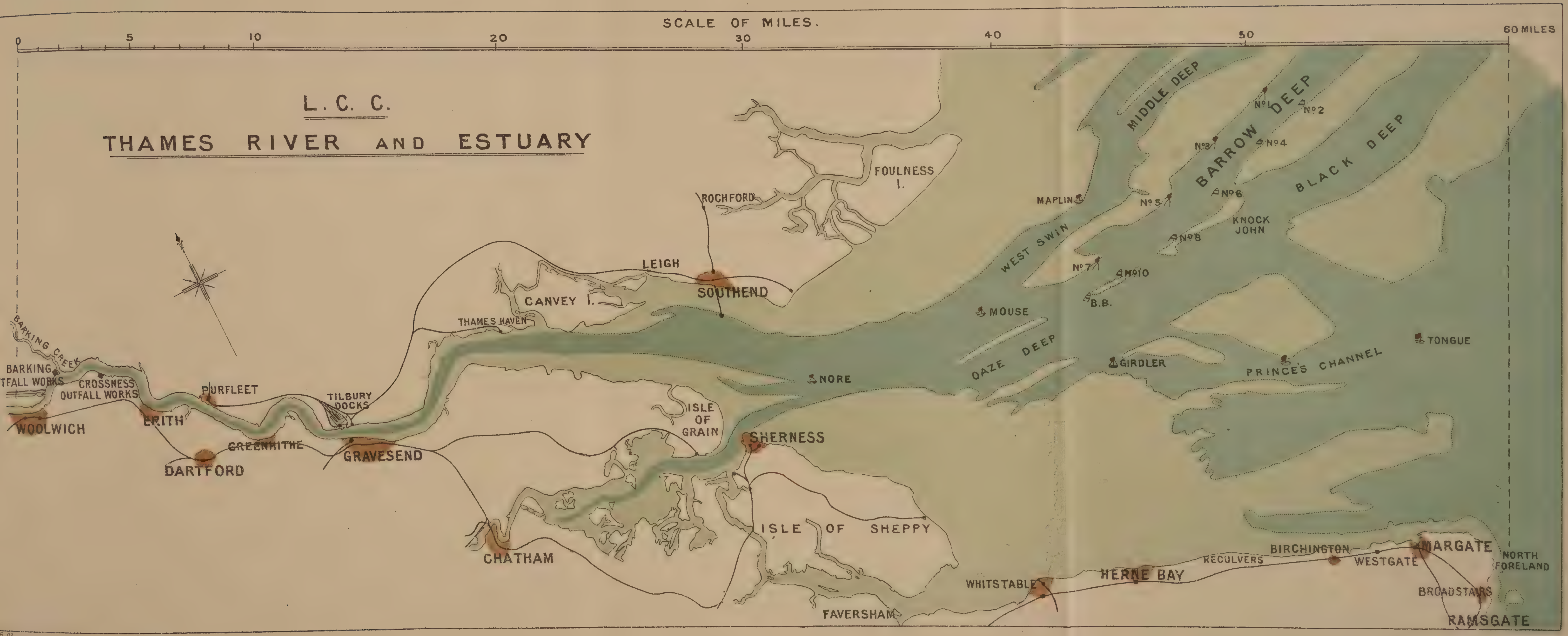
between 1899 and 1900. In 1899 there were 1,152 cases, and in 1900 1,591. There is an extraordinary rise in 1900 and then a great fall in the following year. The rise in 1900 was the continuation of an unusual prevalence which occurred in the autumn of 1899.

19022. It was a special outbreak?—It was a special prevalence. I have here a diagram (see Diagram VI.) showing the behaviour of enteric fever since we have had notification of infectious diseases, and we have almost always, as a result of inquiry, been able to associate a particular outbreak with some particular cause. 1894 is the year that I referred to where I believe the drinking water was involved; in 1891 there was a special outbreak due to the eating of polluted ice-creams in south-east London. The year 1899 was one in which we made inquiry, but found it very difficult to arrive at a conclusion; but these outbreaks are always watched, and we do our best to arrive at an explanation of them.

19023. Do you consider that the falls that took place successively in 1896, 1897, and 1898, were due to the report on oyster culture in relation to disease which the Local Government Board published in 1895?—I do not know, I could not say. My own impression is, from the figures that I have got, that it is the cheaper shell fish that are responsible for the greater part of the enteric fever that is due to polluted shell fish, and I am not sure how far the publication of that report, which I have no doubt influenced many minds, with regard to oysters, would have penetrated to persons who eat cockles and mussels.

Handed in by Mr Maurice Fitzmaurice.
Chief Engineer, London County Council.
14 July 1903.



L. C. C.
THAMES RIVER AND ESTUARY

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DIAGRAM I.

Handed in by Mr Shirley Murphy.

LONDON 1902.

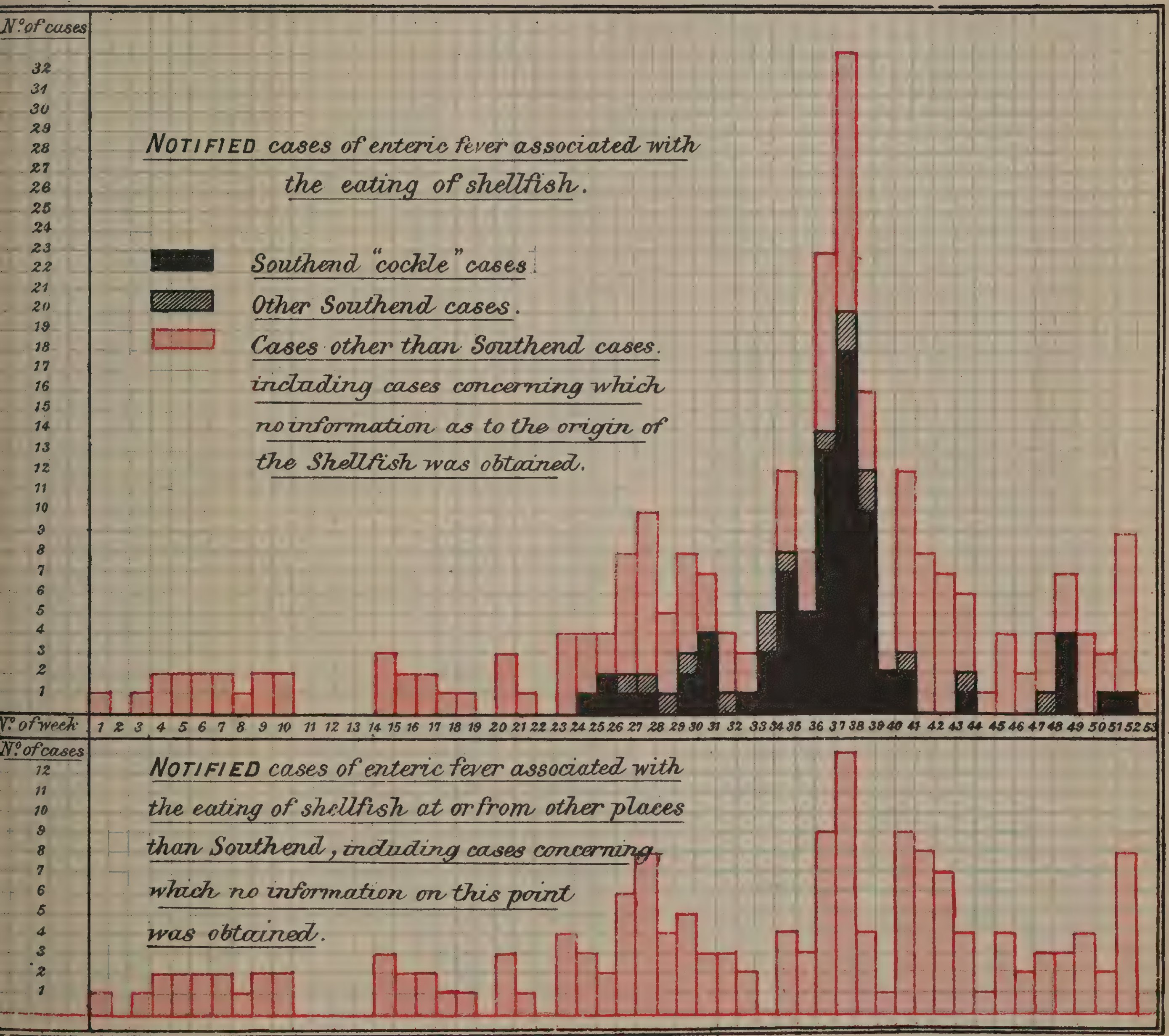

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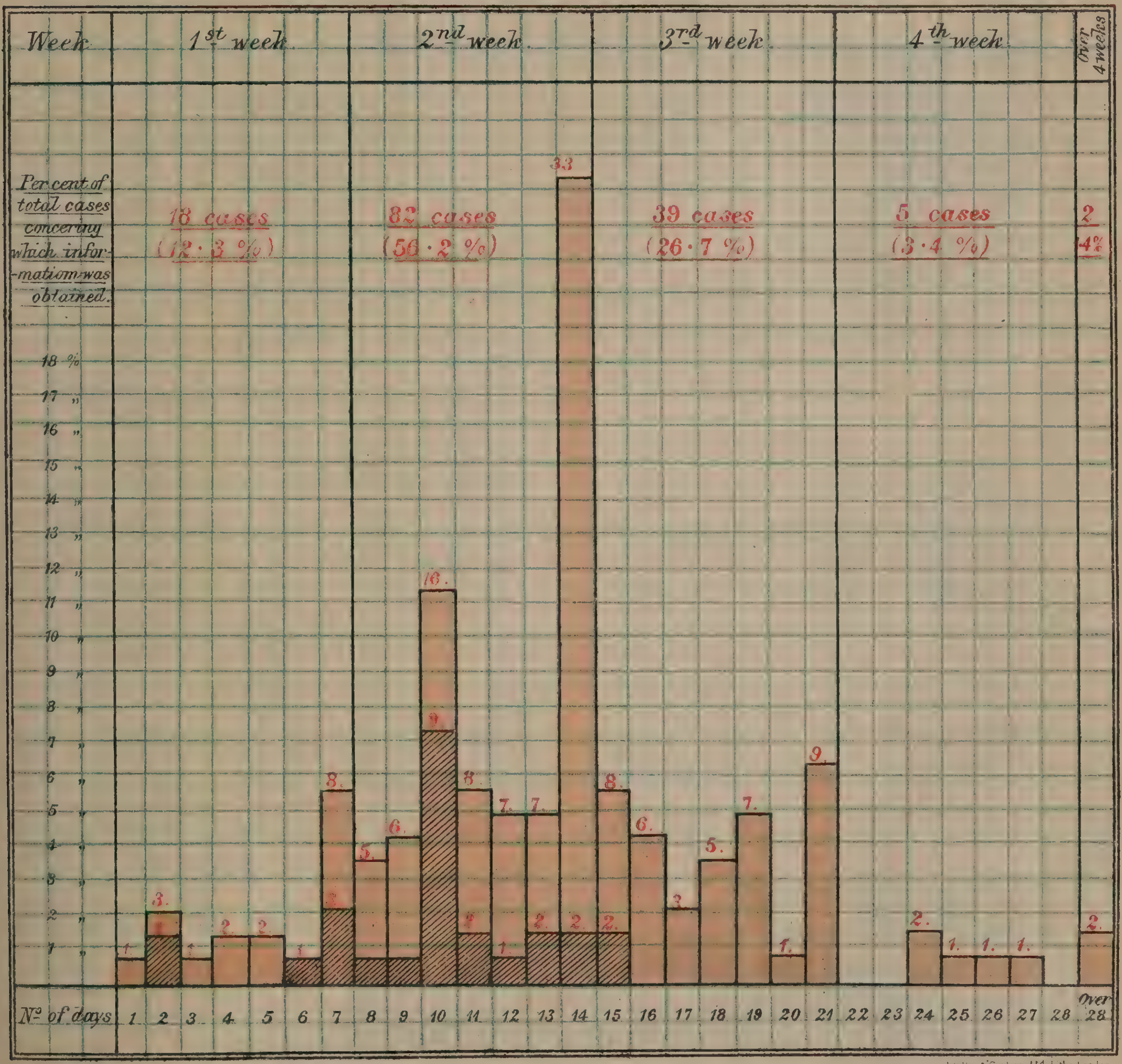
DIAGRAM II.

Handed in by Mr Shirley Murphy.

LONDON 1902.

DIAGRAM shewing the number of cases in which the onset of illness occurred 1.2.3.4 &c. days after eating shellfish, per cent of total cases concerning which precise information on this point was obtained.

The red figure at the top of each vertical column indicates the actual number of cases, and the height of the vertical column represents these figures as a percentage of the total cases, viz 146.



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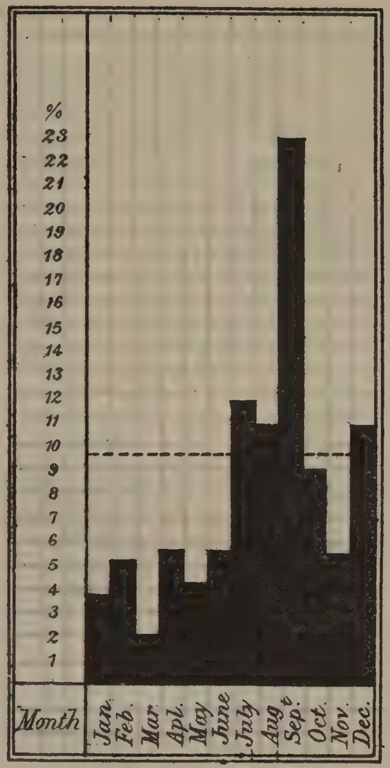
N.B. In some instances the patient had eaten shellfish on more than one day just prior to attack; these cases are distinguished by cross-hatching. Thus on the 10th day shewn in the diagram, for example, 16 persons are stated to have eaten shellfish 10 days before attack and 9 of these persons ate shellfish 10 or more days before attack.

Diagram III.

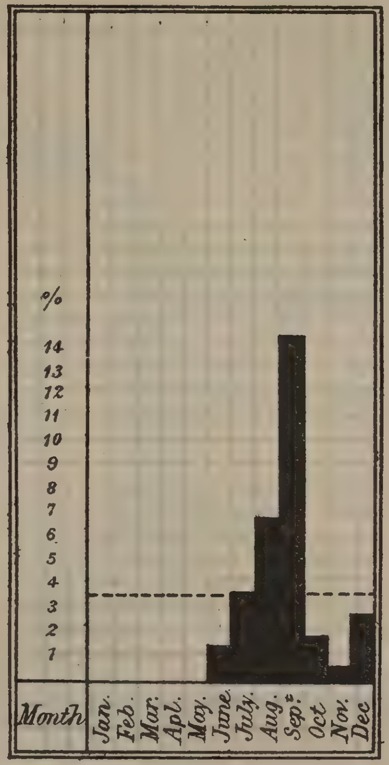
Handed in by Mr. Shirley Murphy.

Notified *cases of enteric fever associated with shellfish eating per cent of total cases in London (excluding five districts).*

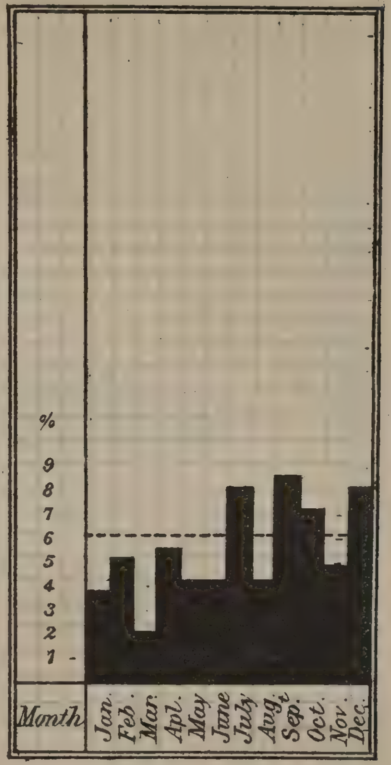
Total Shellfish cases.



Southend cases.



Shellfish cases other than Southend cases, including cases concerning which no information as to the origin of the shellfish was obtained.



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ENTERIC FEVER (NOTIFICATIONS).

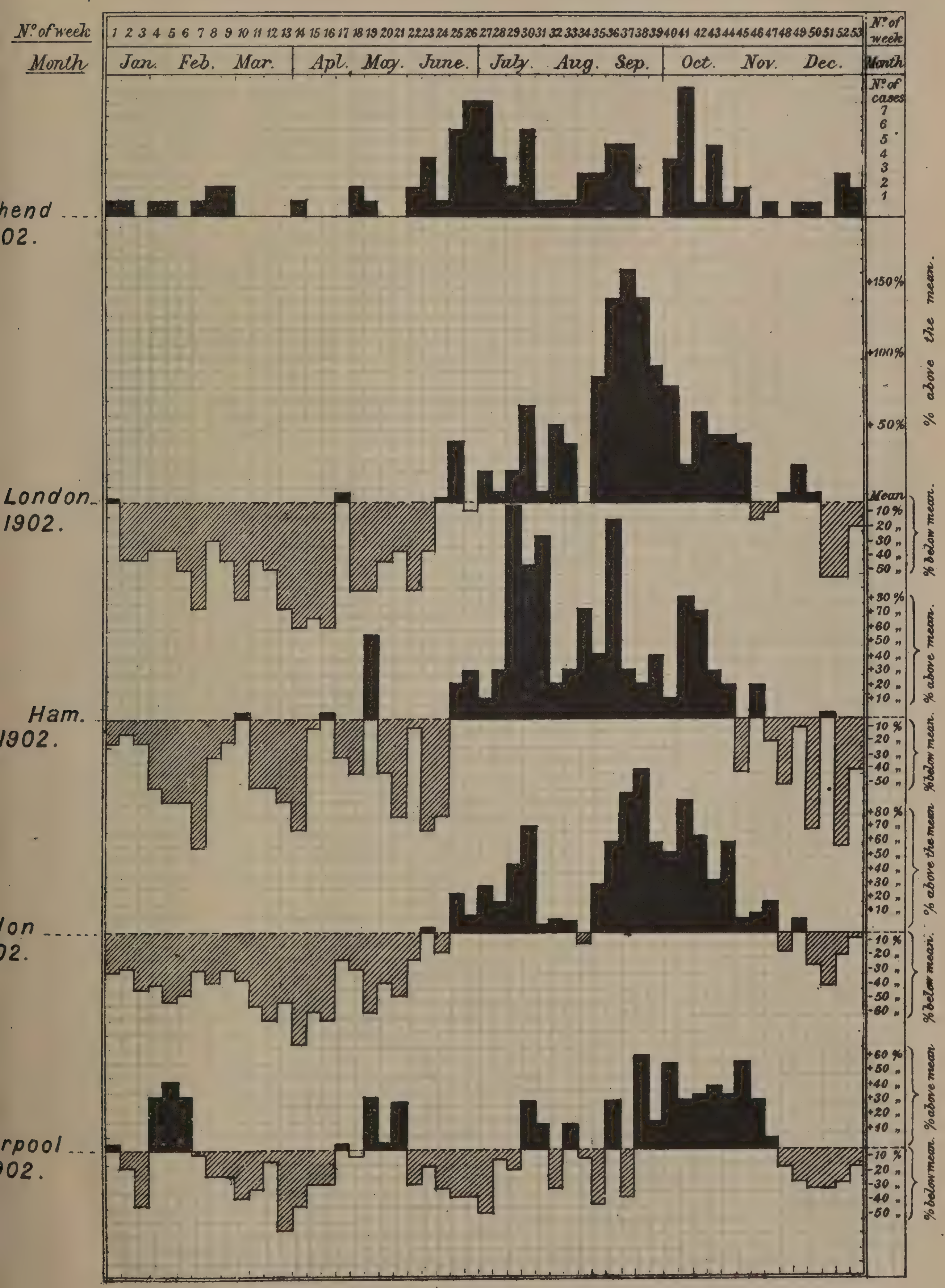

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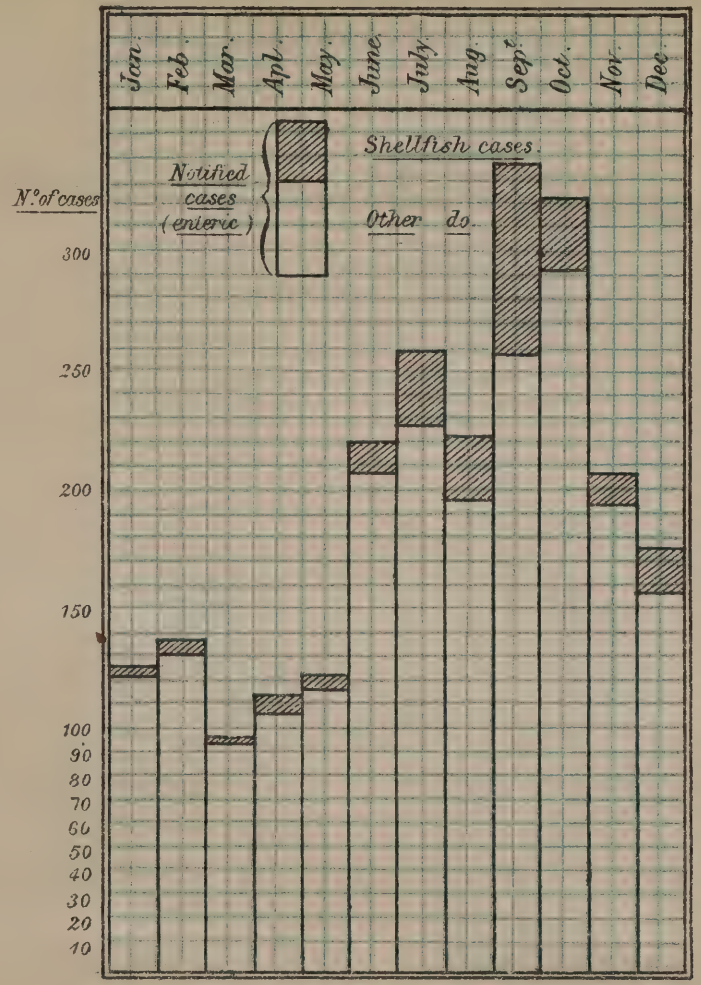
DIAGRAM illustrating the proportion of shellfish cases to total notified cases of enteric fever in London (excluding 5 districts) in 1902.



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Handed in by Mr Shirley Murphy.

DIAGRAM VI.

ENTERIC FEVER. (NOTIFIED CASES)   LONDON 1890-1903.

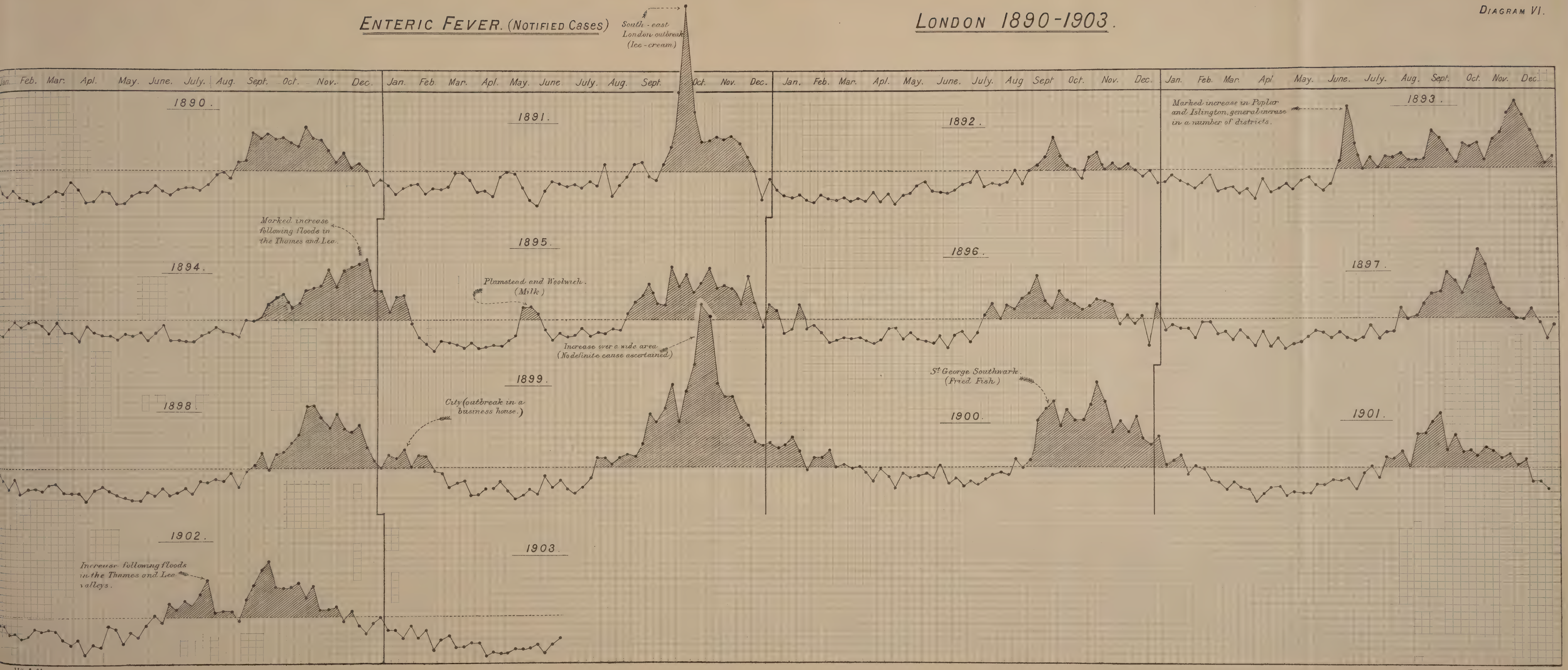

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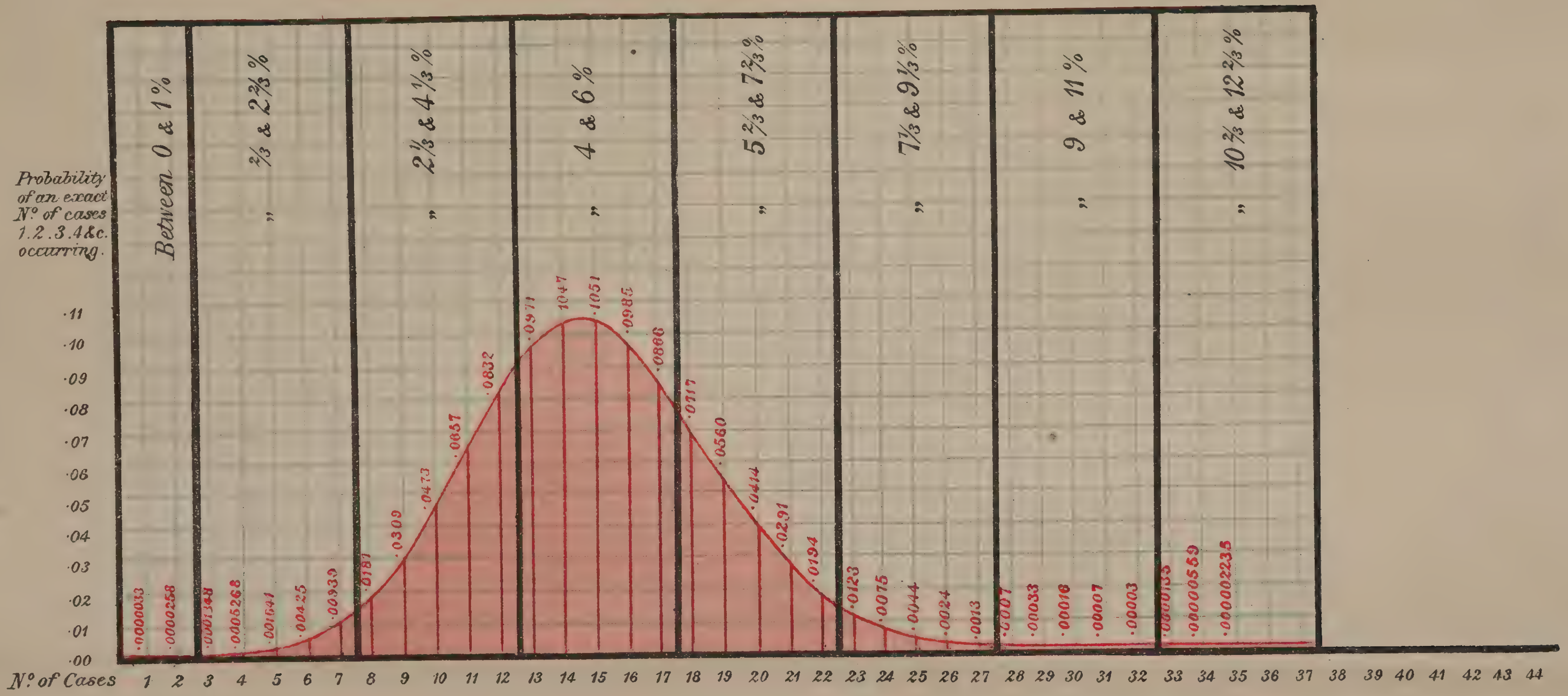
DIAGRAM *shewing the probability of 1, 2, 3 &c. cases of typhoid fever associated with shellfish eating occurring out of 300 cases per month notified in a community 5% of whose members are habitual consumers of shellfish.*

N.B. The probability that exactly 1, 2, 3, 4 &c. cases associated with shellfish eating will occur is denoted by the red vertical lines.

If the area of each parallelogram be taken as unity then the portion of each parallelogram coloured red will represent the probability that between 0 and 1%, ⅔ and 2⅔%, &c, &c, of the persons attacked will be shellfish eaters.



3311. 8. 03.

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SIXTY-FOURTH DAY.

Tuesday, 20th October 1903.

PRESENT:

The Right Honourable The Earl of Iddesleigh (*Chairman*), presiding.

Sir Michael Foster, K.C.B., F.R.S., M.P.
Sir William Ramsay, K.C.B., F.R.S.
Mr. W. H. Power, C.B., F.R.S.
Colonel T. W. Harding, J.P.

Mr. F. J. Willis, *Secretary*.

Also Present:

Dr. A. C. Houston.

Mr. C. C. Hutchinson, Counsel to the Lee Conservancy; Mr. Geo. Corble, Clerk; Messrs. Clapham and Fitch, Solicitors: Mr. C. N. Tween, Engineer; Mr. W. C. Young, Chemist; Mr. Richard B. Croft, Chairman; Mr. Edmund B. Barnard and Mr. Herbert Nield, Conservators; called; and Examined.

Mr. C. C. Hutchinson, Mr. G. Gorble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. G. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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19023.* (*Chairman*). Well, gentlemen, you have given us here the answers to the five preliminary questions that were addressed to you:

"(*a*) The constitution of the Lee Conservancy Board.

"(*b*) The nature and scope of the powers of the Lee Conservancy in regard to pollution and the protection of water supplies.

"(*c*) The method of work adopted by the Conservancy for the detection and prevention of pollution.

"(*d*) The reasons why separate action on the part of the several local authorities has been unsuccessful; and

"(*e*) What alteration in the law the Conservancy consider desirable for the prevention of pollution and the protection of water supplies."

Now I should propose that those papers should be put as they stand on our evidence, and they will therefore be there in that permanent shape.

MEMORANDUM BY THE LEE CONSERVANCY BOARD.

20th October, 1903.

Lee Conservancy Offices,
12, Finsbury Circus,
London, E.C.

CONSTITUTION OF BOARD.

The River Lee is a very ancient river, and has been navigable from time immemorial; the earliest historical record being about the year 894.

The earliest Acts of Parliament were passed in the reign of Henry VI., 1424 and 1430. These Acts empowered the Lord Chancellor for the time being to issue commissions for the purpose of clearing and scouring and amending the River "Ley," and to provide for the better passage of ships and boats.

The next Act was that of 13th Elizabeth, cap. 18, 1570. This gave powers to the Lord Mayor, Commonalty and Citizens of London, to improve the River Lee; also power to the Lord Chancellor to issue commissions for keeping the river in order.

The next Act was 12th George II., cap. 32, 1739, by which certain gentlemen and Members of Parliament therein named were appointed as trustees for the government of the river, with power to sue out the Commissioners of Sewers.

Then followed 7th George III., cap. 51, 1766. This was the first real Lee Navigation Improvement Act, giving general powers to improve the river, to levy tolls, and to borrow money.

New trustees, to the number of over 200, including most of the large landowners near the Lee, in the counties of Herts, Essex, and Middlesex, were appointed to carry the Act into execution.

19th George III., cap. 58, 1778.

A further improvement Act.

45th George III., cap. 69, 1805.

A further improvement Act.

13th and 14th Vic., cap. 109, 1850.

The principal objects of this Act were to enable the trustees further to improve the navigation, and to dispose of the surplus water to the New River and East London Water Companies, by which they were to pay certain annual sums for the water taken.

Power to trustees to borrow money up to £230,000.

18th and 19th Vic., cap. 196.

"THE RIVER LEE WATER ACT, 1855."

By this Act the surplus water of the Lee, over and above the quantity required for the purposes of the navigation, was vested in the two water companies for ever.

This Act fixed the annual payments by the water companies as follows:—

New River - - -	£1,500 per annum.
East London - -	2,000 ,, ,,

In addition to these rents, the New River Company paid the Lee Trustees a capital sum of £42,000, to be expended in works for the improvement of the navigation.

In the preamble of that Act it recites that the two companies derived large quantities of water from the river, and were executing extensive and important works for preventing the fouling of such water.

The following are the sections defining the water rights under this Act:—

Water of Lee vested in the Companies.

> IX. Subject to the provisions of this Act, all the water from time to time flowing into or down the River Lee and the navigation thereof, which the trustees have now power to sell under the Trustees Act of 1850, except such quantities thereof as are by this Act reserved to the trustees for the purposes of the navigation, is by this Act transferred to, and shall be absolutely vested in, the two companies for ever, provided always that nothing herein contained shall be held to give to the two companies, or either of them, any right to such water which does not belong to the trustees, or which they have not now the power to sell.

Reservation to Trustees of daily Quantities of Water.

> XI. Provided always that there are by this Act reserved to the trustees, for the purposes of the navigation, to pass through the several present and future locks on the navigation, and at their discretion, and not subject to any control by the two companies, or either of them, either with or without barges, any quantities of water, not exceeding the following daily qualities; to wit, first, they may pass through the several locks from the highest point at which the two companies, or either of them, may hereafter take their supply down to and including the then first lock above Field's Weir (and which part of the river is in this Act called the Upper Reach) any quantities not exceeding in the whole, in any one day of twenty-four hours, 576,000 cubic feet (in this Act called the upper daily quantity); secondly, they may pass through the several locks from the then first lock above Field's Weir exclusive down to and including Waltham Town Lock (and which part of the river is in this Act called the Middle Reach) any quantities not exceeding in the whole, in any one day of twenty-four hours, 720,000 cubic feet (in this Act

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Priority of Rights to Water.

called the middle daily quantity); and, thirdly, they may pass through the several locks from Waltham Town Lock exclusive down to and including Old Ford Lock (and which part of the river is in this Act called the Lower Reach) any quantities not exceeding in the whole in any one day of twenty-four hours, 864,000 cubic feet (in this Act called the lower daily quantity).

XXX. The several rights of the trustees and of the two companies respectively with respect to the water from time to time flowing into or down the River Lee, and the navigation thereof, shall have the following priorities; to wit,

First, the right of the trustees to the upper daily quantity, the middle daily quantity, and the lower daily quantity respectively within the limits of the Upper Reach, the Middle Reach, and the Lower Reach respectively, and such further quantity, subject, as aforesaid, as shall be necessary to maintain the water of the navigation on a level with the head levels aforesaid.

Secondly, the right of the New River Company to take 2,500 cubic feet a minute.

Thirdly, the right of the East London Company to take 2,500 cubic feet a minute.

Fourthly, the right of each of the two companies to take, *pari passu*, 500 cubic feet each a minute.

Fifthly, the right of each of the two companies, after such notice in that behalf, as by this Act provided, to take, *pari passu*, any additional quantity of water.

Sixthly, the right of the trustees to surplus water below Tottenham Mill.

31st and 32nd Vic., cap. 154.

"THE LEE CONSERVANCY ACT, 1868."

This Act effected an entire reconstitution of the governing body of the Lee, and dealt specially with the pollution question. It abolished the old body of trustees, and formed a new Conservancy Board, consisting of 13 members, as follows:—

5 elected in the first instance by the trustees, and afterwards by the landowners.
1 elected by owners of barges.
1 elected by local authorities.
2 appointed by New River Company.
2 appointed by East London Water Company.
1 appointed by Corporation of London.
1 appointed by Metropolitan Board of Works.

13

On the 18th May, 1865, a Royal Commission was issued to inquire into the best means of preventing the pollution of certain rivers, among which was the River Lee. In consequence of the outbreak of cholera in the district supplied by the East London Waterworks, it was deemed advisable to make an early inquiry into the pollution of the River Lee. Meetings of the Commissioners were held at Luton, Bishops Stortford, Tottenham, Hertford, and Ware, in addition to meetings at the Commissioners' offices in London. Witnesses were examined at considerable length as to the constitution of the Lee Trust, and the powers of the trustees to deal with river pollution. The Commissioners came to the conclusion that the constitution of the Lee Trust was not fitted for a Board of Conservators, and that the interests which demanded representation in any body having the government of the River Lee were the navigation, the riparian owners, the towns on the banks of the different streams, the traders and wharfingers using the river, both the great water companies, and the water consumers.

In drawing the Bill they took as a precedent the Thames Conservancy Act of 1866, and the protection of water clauses.

In the Lee Conservancy Act, Sections 89 to 97 were practically copied from the Thames Act of 1866.

By the 1868 Act the two Water Companies were, by Section 131, required to pay to the Lee Conservancy Board the sum of £1,000 per annum to enable them to carry out the duties of preserving the purity of the water. This amount was wrung from the Water Companies after much opposition, as it was considered at the time, as the evidence on the Bill will show, that to properly preserve the purity of the water of the Lee a sum of at least something like £3,000 would be required

The preamble of the Act states that:—

> "Whereas a large proportion of the water supplied to the metropolis is drawn from the Lee, and the Lee is extensively used for purposes of navigation, and for those and other reasons the preservation of the purity of the water of the Lee and its tributaries, and the improvement of the stream, bed, and banks thereof, and the maintenance and improvement of the cuts, locks, and other navigation works on the Lee are objects of great public and local importance."

37th and 38th Vic., cap. 96, 1874, gave the Conservancy some further powers, but not with regard to pollutions or protection of water. It also fixed their remuneration at £1,000 per annum.

The Conservancy Board, as thus constituted, continued to carry out the Act until the year 1890, when the London County Council made an attempt in a general Bill of their own to put two more members on the Conservancy. In this they failed. They again tried in 1893, with a similar result. In 1898 the West Ham Corporation, through a Bill of their own, tried to get a special representative on the Conservancy, but failed likewise. In 1899 the London County Council again asked for a revision of the Conservancy by having seven of their members on it, and altering the total number of Conservators to fifteen.

The Conservancy having expended something like £2,000 in defeating these attempts for revising their constitution, themselves agreed to promote a Bill in Parliament for that purpose. This they accordingly did in the Session of 1900, when, after considerable opposition and a lengthy hearing, the Act of 63rd and 64th Vic., cap. 117,

"THE LEE CONSERVANCY ACT, 1900,"

was passed.

The Act fixed the number of Conservators as follows:—

Appointed members—
- One by the Bedfordshire County Council;
- One by the Hertfordshire County Council;
- One by the Essex County Council;
- One by the Middlesex County Council;
- Two by the London County Council;
- One by the Corporation of London;
- One by the Corporation of West Ham;
- One by the New River Company;
- One by the East London Waterworks Company.

Elected members—
- One by the local authorities in Hertfordshire mentioned in the first part of the schedule to this Act;
- One by the local authorities in Essex mentioned in the second part of the said schedule;
- One by the local authorities in Middlesex mentioned in the third part of the said schedule;
- One by the local authorities mentioned in the fourth part of the said schedule;
- One by the barge owners.

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Term of office, three years.

The following is the schedule above referred to:—

PART I.

Local Authorities in Hertfordshire.

Hertford Corporation.
Hertford Rural District Council.
Welwyn Rural District Council.
Ware Urban District Council.
Ware Rural District Council.
Buntingford Rural District Council.
Bishops Stortford Urban District Council.
Hatfield Rural District Council.
Hadham Rural District Council.
Hoddesdon Urban District Council.
Cheshunt Urban District Council.
Sawbridgeworth Urban District Council.
East Barnet Valley Urban District Council.
St. Albans Rural District Council.
Hitchin Rural District Council.
Harpenden Urban District Council.
Stevenage Urban District Council.
Ashwell Rural District Council.
Barnet Rural District Council.
Barnet Urban District Council.

And any municipal corporation or district council to

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be hereafter created the area within whose jurisdiction is wholly situate in the watershed of the River Lee or its tributaries in Hertfordshire.

PART II.

Local Authorities in Essex.

Saffron Walden Rural District Council.
Stanstead Mountfichet Rural District Council.
Dunmow Rural District Council.
Waltham Holy Cross Urban District Council.
Epping Urban District Council.
Epping Rural District Council.
Walthamstow Urban District Council.
Leyton Urban District Council.
Chingford Urban District Council.

And any municipal corporation or district council to be hereafter created the area within whose jurisdiction is wholly situate in the watershed of the River Lee or its tributaries in Essex.

PART III.

Local Authorities in Middlesex.

Enfield Urban District Council.
Edmonton Urban District Council.
Tottenham Urban District Council.
Friern Barnet Urban District Council.
Southgate Urban District Council.
Wood Green Urban District Council.

PART IV.

The Hackney Vestry.
The Limehouse Board of Works.
The Poplar Board of Works.

The present Board was elected in March, 1901, and continues in office until the first Friday in April, 1904.

By this Act (Section 25) the rents payable by the Water Companies for abstracting water from the River Lee, under the terms of the Act of 1855, were increased as follows:—

New River Company - - -	£3,750
East London Water Company -	4,250
	£8,000

as Parliament considered the rents fixed by the old Act were inadequate considering the quantity of water abstracted from the river, and the cost thrown on the Conservancy of properly maintaining the navigation, dredging, payment of interest on their debt, sinking fund, etc.

Also the amount payable by the two Companies under the 131st section of the Act of 1868 of £1,000 per annum was increased to £2,000 (*see* Section 25).

ACCOUNTS.

The income of the Conservancy, including the increased water rents from the Companies, is made up approximately as follows:—

Tolls - - - - - - -	£15,629
Water rentals - - - - -	7,888
Rentals of properties - - -	1,715
Other receipts - - - - -	268
	£25,500

PAYMENTS.

Interest on debt - - - - -	£7,450
Salaries, including staff, collectors, lock keepers, weir keepers, and pensions - - - - - -	3,655
Works for maintenance and navigation, dredging, etc. - - -	8,500
Rent charges - - - - - -	558
Office and general expenses, including rates and taxes £1,444 - -	2,354
Conservators' fees - - - - -	1,000
Law and Parliamentary - - -	357
Sinking fund - - - - - -	1,500
	£25,374

DEBT ACCOUNT, 3RD APRIL, 1903.

	£	s.	d.
Perpetual Debenture Stock, 4 per cent. - - -	£186,632	0	0
"Lee Conservancy Redeemable Debenture Stock," 3½ per cent., redeemable at par on 1st January, 1953-	15,150	0	0
Total debt on 3rd April, 1903 - - - -	£201,782	0	0

PROTECTION OF WATER ACCOUNTS.

For the five years preceding 1900 the average receipts from the Water Companies under this heading amounted to £1,000 a year, and expenses about the same. From that time the accounts have been as follows:—

1901.

PROTECTION OF WATER ACCOUNT

Dr. For Year ended 5th April, 1901. *Cr.*

RECEIPTS.	£.	s.	d.	£.	s.	d.
To Additional Payments by Water Companies, under 131st Section of "Lee Conservancy Act, 1868," namely—East London Water Works Company -	666	13	4			
New River Company - -	333	6	8	1,000	–	–
Balance overdrawn - - - - - -				67	14	4
£.				1,067	14	4

PAYMENTS.	£.	s.	d.	£.	s.	d.
To Balance overdrawn on last Year's Account - - - - - - - -				45	10	1
By Salaries—Sanitary Engineer	350	–	–			
Portion of Clerk's and Auditor's - - - - -	104	16	8			
By Consulting Chemist—Retaining Fee - - - - -	5	5	–			
By Sanitary Engineer's Travelling and Incidental Expenses	150	–	–			
By Water Bailiff's Wages - -	104	–	–			
By Water Bailiff's Travelling Expenses - - - - -	32	4	9			
By Office Rent - - - - -	80	–	–			
By Office Disbursements - -	86	8	2			
By Printing, Stationery, Pamphlet, &c. - - - - -	36	7	3			
By Law Expenses - - - -	52	6	–			
By Annual Survey Expenses -	10	–	–			
By Analyses - - - - -	6	6	–			
By Sundries - - - - -	4	10	–	1,022	4	3
£.				1,067	14	4

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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1902.

PROTECTION OF WATER ACCOUNT.

For the Year ended 4th April 1902.

Dr.

RECEIPTS.	£.	*s.*	*d.*	£.	*s.*	*d.*
To Additional Payments by Water Companies under Section 131 of "Lee Conservancy Act, 1868," and Section 25 of "Lee Conservancy Act, 1900," namely—East London Water Works Company - - -	902	6	6	1,353	9	9
New River Company - - -	451	3	3			
£.				1,353	9	9

Cr.

PAYMENTS.	£.	*s.*	*d.*	£.	*s.*	*d.*
To Balance overdrawn on last Year's Account - - - - - - -				67	14	4
By Salaries—Sanitary Engineer	75	–	–			
Portion of Clerk's and Auditor's - - - -	107	2	6			
Portion of Engineer's - -	37	10	–			
By Pensions—Widow of the late Sanitary Engineer - - -	137	10	–			
By Consulting Chemist—Retaining Fee - - - -	5	5	–			
By Engineer's Travelling and Incidental Expenses - -	25	–	–			
By Wages of three Water Bailiffs - - - - -	158	–	–			
By Travelling Expenses of Bailiffs - - - - -	64	12	8			
By Office Rent - - - -	80	–	–			
By Office Disbursements - -	84	1	9			
By Printing, Stationery, Pamphlets, &c. - - - -	56	6	6			
By Law Expenses - - -	61	18	1			
By Annual Survey Expenses -	10	–	–			
By Analyses - - - -	72	9	–			
By Sundries - - - -	69	9	6			
By Dredging Foul Sewage Mud from River below Ware Lock	230	8	–	1,274	13	–
By Balance carried to next year's Account -				11	2	5
£.				1,353	9	9

1903.

PROTECTION OF WATER ACCOUNT.

For Year ended 4th April 1903.

Dr.

RECEIPTS.	£.	*s.*	*d.*	£.	*s.*	*d.*
To Balance in Hand, 4th April 1902 - - - - - - -				11	2	5
To Additional Payments by Water Companies, under Section 131 of "Lee Conservancy Act, 1868," and Section 25 of "Lee Conservancy Act, 1900," namely—						
East London Water Works Company - - -	1,333	6	8			
New River Company -	666	13	4			
	2,000	–	–			
Deduct amount still due from the East London Water Works Company	486	18	8	1,513	1	4
To Fines - - - - - - - -				6	1	–
				1,530	4	9
To amount overdrawn - - - -				313	8	7
£.				1,843	13	4

Cr.

PAYMENTS.	£.	*s.*	*d.*	£.	*s.*	*d*
By Salaries—						
Portion of Clerk's and Auditors . - -	107	1	4			
Portion of Engineer's -	50	–	–			
Portion of Engineer's Assistants' - - - -	50	–	–			
Clerical Assistance (Engineer's Office) - - -	40	–	–			
By Pensions—Widow of late Sanitary Engineer - - -	150	–	–			
By Consulting Chemist—Retaining Fee - - - -	5	5	–			
By Wages of three Water Bailiffs	195	–	–			
By Travelling Expenses of do.	51	17	8			
By Office Rent - - - -	117	3	9			
By Office Disbursements - -	93	6	–			
By Printing, Stationery, Pamphlets, &c. - - - -	51	4	2			
By Law Expenses - - -	75	–	–			
By Annual Survey Expenses' -	10	–	–			
By Analyses - - - -	191	8	6			
By Sundries - - - -	9	8	5			
By Lower Lee Valley Sewer Scheme, Preparation of Plans Surveys, Reports and Disbursements - - - -	582	18	6	"A"		
By Office Repairs - -	64	–	–			
				1,843	13	4
£.				1,843	13	7

In 1902, and likewise in the present year, 1903, the Companies have objected, pursuant to their power to do so under Section 131 of the Act of 1868, against certain items in the accounts, with regard to the preparation of plans, surveys, etc., for the Lower Lee Valley Sewer Scheme, and the question has now been referred to an arbitrator appointed by the Board of Trade.

Mem.: This question of the Lower Lee Valley Sewer will be dealt with hereafter.

THE NATURE AND SCOPE OF THE POWERS OF THE LEE CONSERVANCY BOARD, ETC.

The watershed area embraces about 600 square miles. The navigation is about 28 miles in length from Hertford to the Thames. At Fields Weir, near Hoddesdon, it is joined by the Stort, a river navigable for 13 miles up to Bishops Stortford.

The powers of the Conservancy with regard to pollutions and the protection of water supplies are defined by the Acts of 1868 and 1900. Section 89 of the former Act enacts as follows:—

> 89. "The Conservancy Board may by all lawful and proper means preserve and maintain at all times as far as may be the purity of the water of the Lee and its tributaries; and also (but subject to the lawful exercise of any rights of taking, impounding, or using the water) the flow of the water of the Lee and its tributaries; and the discharge of that duty and the proper exercise and execution of the powers and functions of the Board in relation thereto, and the prevention of pollution shall be deemed purposes of this Act."

Sections 91 to 100 gave the Conservancy power to serve notices on any person or body polluting the river or any of its tributaries, giving them not less than one year or more than three years to stop the same; the penalty for non-compliance being £100, and £50 for every day after the day on which the offence was continued. There was also a provision prohibiting the placing of manure, etc., on the banks of the Lee or any of its tributaries, so that the same might run or drain into the river; penalty £10 and £5 a day afterwards.

In this Act several saving clauses were obtained with regard to the then existing drainage, such as the town of Luton (Section 101), the town of Hertford (Sections 102-3-4), Tottenham (Section 105), Metropolitan Storm Outfalls, Old Ford (Section 106), E. Cook and Co., Bow (Section 107), West Ham (Section 108). These saving clauses have been a great source of trouble and expense to the Conservancy since the passing of the Act, and the subject will be dealt with later on.

By the Act of 1900 some slightly increased powers were given to the Conservancy with regard to the prevention of pollution; thus in place of giving 12 months' notice the Board can give three months' (Section 28).

Section 29.—Notices with respect to pollution to affect successive owners.

Section 30.—Extra powers as to entry on land or premises, for purposes of examination, between the hours of 9 a.m. and 4 p.m.

Section 31.—Extra powers as to taking samples.

Section 32.—Provision as to prohibiting the use of unseaworthy or leaky barges used for the carriage of manure, gas lime, refuse, or other offensive matter.

Section 35.—Power to make bye-laws for requiring the owners, masters, and persons in charge of any vessel or barge carrying any manure, gas lime, street sweepings, rubbish, or refuse of any description, to properly cover the same.

Section 109 of the 1868 Act was repealed, and additional powers given with regard to throwing polluted matter into the water, or depositing collections of offensive stuff on the banks.

The following is the new section:—

ition
wing
, &c.,
er.

> 27. Section 109 of the Act of 1868 is hereby repealed. If any person without lawful excuse (the proof whereof shall lie upon him) does any of the following things, namely:—
>
> (1) Unloads, throws, or puts, or causes, or suffers to fall, any gravel or any substance which has been used as ballast, or any stones, earth, mud, ashes, dirt, soil, or rubbish, or any refuse from any manufactory into the River Lee or its tributaries or on the shores thereof;
>
> (2) Knowingly puts any such gravel or other thing as aforesaid in any place where the same is likely to be carried into the River Lee or its tributaries by floods;
>
> (3) Wilfully causes or suffers any offensive matter or waste manufactured products, whether solid or fluid, or any matter likely to silt up or form obstructions, to flow or pass into the River Lee or into any tributary thereof;
>
> (4) Puts or allows to remain for more than 48 hours any heap or collection of manure, gas lime, ashes, town sweepings, refuse, or other offensive matter, whether solid or fluid, in such a position that the same will or may be likely to drain, be blown, or pass into the River Lee or any such tributary;
>
> he shall for every such offence be liable to a penalty not exceeding £20, and to a daily penalty not exceeding £10.
>
> Any officer of the Board may, on producing his authority, signed by the clerk, enter and board any vessel or barge for the purpose of examining the same, and ascertaining whether any offence against this enactment has been or is being committed.
>
> Where any offence against this enactment is committed from or out of a vessel, the master and the owner of the vessel shall be liable to be proceeded against and punished under this enactment so that the master and the owner of the vessel be not both punished in respect of the same offence. Any constable, and any person called by a constable to his assistance, may take into custody without warrant any person found committing any offence against Sub-Sections (1), (2), and (3) of this section.

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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This section, if strictly enforced, would practically abolish the carriage of manure, gas lime, etc., up the Lee and Stort, and inflict a great hardship on the landowners and farmers.

Luton.—This place, which gave a deal of trouble to the Conservancy some years ago, has since had the sewage put on very high ground a long distance from the river, and no pollution has been caused since.

Tottenham.—Owing to the great public outcry in 1885 as to the pollution of the Lee below this place, an Act of Parliament was obtained, by which ("The Lee Purification Act, 1886") for four months of the year—from 1st June to 30th September—the sewage was allowed, under certain restrictions, to pass into the sewers of the Metropolitan Board of Works. This body was succeeded in 1889 by the London County Council, who, by the Tottenham and Wood Green Sewerage Act, 1891, 54 and 55 Vic., c. 205, agreed, under conditions, to admit a limited volume of the sewage into the metropolitan system through the Hackney sewers. Except in times of heavy storms no sewage flows from this place into the Lee.

Storm Outfalls—Metropolitan Sewers—Old Ford—London County Council.

The discharge from these, even at times of very moderate rainfall, largely pollutes the lower parts of the Lee and tributaries in the populous districts of Stratford, West Ham, Bow, and Poplar. The northern outfall sewer enlargement, which is now being carried out by the London County Council, will, it is anticipated, when completed, greatly decrease the pollution from this source. The Conservators have for years past been in communication with the L.C.C. as to this, and the Council pay the Conservancy an annual sum for dredging out the deposits brought into the river from these outfalls.

E. Cook and Co., Bow, have made arrangements to connect with the local sewer.

West Ham.—The sewage or effluent from this large district, which formerly passed into Bow Creek, is now joined to the metropolitan system, and any pollution to the lower part of the Lee from this source is now removed.

Hertford.—This place, which may be justly described as one of the greatest blots in the Lee watershed, must be dealt with at some length.

From a sanitary point of view Hertford has been conspicuous. Its sewage formerly was a cause of great direct pollution to the Lee and the water of the New River.

The town was sewered at considerable cost by the New River Company in 1854, so as to divert the sewage of the town of Hertford to a point below their intake; thus recognising the principle of expending money in freeing their sources of supply from possible pollution. So badly was the work done that the infiltration of subsoil water to the sewers has been a source of trouble ever since.

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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The following are the sections affecting this:—

The New River Company's (Hertford Sewerage Diversion) Act, 1854 (17 Vic., cap. 39).

Company not to discharge Sewage Water into the River Lee until purified.

VIII. Provided always that the Company shall not at any time discharge or permit any sewage or sewage water to flow from any of the sewers or drains by this Act authorised, immediately or mediately, into any part of the River Lee or of the River Lee Navigation, until after it has been subjected to the process of purification known as Higg's patent process, intituled in the letters patent thereof "The means of collecting the contents of sewers and drains in cities, towns, and villages, and for applying the same to agricultural and other useful purposes," or some other process which from time to time may be in use as the best then known practicable process for the purification thereof.

Board of Trade to decide as to Proceeding of Purification.

IX. That if any question shall arise between the Company and any of the parties interested in the waters of the same river or navigation as to the *bonâ-fide* compliance with this provision, the parties in difference or either of them may refer the question to the Board of Trade, and that Board may make such inquiries thereon as it thinks fit, and may declare what in its opinion is the best then known practical process for such purification; and every such declaration, until it be superseded by a subsequent declaration of the Board in the premises, shall, for the purposes of this Act, be conclusive as to what is the best then known practicable process for such purification; and the expenses from time to time incurred by the Board in the premises shall be ascertained by the Board, and shall be paid by the parties in difference, or one of them, as the Board directs.

As long ago as 1864 the Town of Ware complained of the state of the river below the mouth of the Manifold Ditch, where the Hertford effluent entered the River Lee Navigation. In 1869 the Conservators served Hertford with a notice under the Act of 1868 to discontinue the nuisance, and for years afterwards there were constant differences of opinion between the Board and the Corporation as to the effluent discharged, the Corporation always contending that they were using the best known practicable process as directed by the Act of 1854.

In 1884 an action in the High Court, Chancery Division, was taken by the Conservators of the river against the Corporation and others. It was tried before the late Mr. Justice Watkin Williams. The case lasted thirteen days, and was remarkable for the facts, parallels, and contradictions of the evidence.

The action was brought in order to obtain an injunction to restrain the defendants from causing or permitting any of the sewage from the town of Hertford to flow into the River Lee, and from causing or permitting any water containing any impure or foreign matter, whether in solution or not, to flow from the sewage works into the river, and also for damages for the injury done by the pollution of the river and the deposit or accumulation therein of mud from the sewage. The Judge viewed the spot on 16th February, 1884. The following are from his notes:—"Manifold ditch—a broad black ditch—water in ditch appeared very foul to the eye—peculiar dark blue shade of colour in the water and very marked smell of sewer-gas—followed ditch through meadows—ditch very foul and filthy, with strong odour of sewage—from this point to aqueduct of New River, sides and bottom of the channel covered with a foul and filthy-looking growth—unmistakeable odour of sewage. I believe my nose appreciated the smell all the way until I got my nose into the culvert on by the sewage works—it seemed to me I followed it just as a foxhound follows the scent of a fox, right up there."

Judgment:—"I find that no real injury, pollution, or nuisance has been caused by the Corporation to the waters of the Lee." Action dismissed with cost; these amounted to over £6,000.

The "Royal Commissioners on Metropolitan Water Supply" reported in 1893, as follows:—(Sec. 175, p. 70): "Some of our number have also visited the locality and inspected the sewage works and we are of opinion that the state of matters now existing ought to be remedied without delay."

From that time the river continued to be in as bad a state as ever, or even worse. Complaints were continuous, particularly from the Town of Ware. But the Conservancy paused before again taking action against Hertford, especially after the foregoing judgment.

In 1896 considerable correspondence took place between the Conservancy, the Board of Trade, and the Local Government Board in reference to the Act of 1854, the last letter being as follows:—

Board of Trade
(Railway Department),
7, Whitehall Gardens,
London, S.W.
30th December, 1896.

New River Company's (Hertford Sewage Diversion) Act, 1854.

Sir,—With reference to your letter of the 26th ult., and the subsequent interviews between the chairman of the Lee Conservancy and Mr. Ritchie, I am directed by the Board of Trade to state that they have carefully considered the application made by the Conservancy under Section 9 of the Act above-mentioned, and the representations urged by them in support of it.

That application gives rise to questions of considerable difficulty. It is apparent that the provisions of the Act of 1854 now under consideration must be construed in conjunction with the provisions of the Lee Conservancy Act, 1868, relating to the purity of the River Lee and its tributaries, and, in view of the elaborate remedial machinery provided by the later Act, it is desirable that the Conservancy should not merely satisfy the Board of Trade that Section 9 of the Act of 1854 is still operative, but should convince them of the necessity or propriety of proceedings under that Section.

The assistance of this department is sought on the ground that the funds of the Conservancy are insufficient to allow of their embarking in another heavy lawsuit, similar to that of 1884. They are no doubt bound to fulfil certain obligations imposed upon them by the Acts as trustees for the purpose of securing the purity of the River Lee. The Board of Trade appreciate the position of the Conservancy in that respect, but the Acts also levy a yearly contribution of £1,000 (as a maximum) upon the two water companies who benefit by the protective measures in question, and this contribution is expressly stated to be a provision for the expenses incurred by the Conservancy in exercising their powers and functions as trustees for preserving the purity of the Lee. That contribution is in addition to a yearly sum of £3,500 previously payable to the Conservancy by the two companies under the Act of 1855. It seems clear that the Legislature did not intend that their liability to take proceedings as trustees in the interests of the water companies should be unlimited, for there is an express safeguard in Section 98 of the Act of 1868 against any such unlimited liability. If the Conservancy Board do not think fit to take legal proceedings when required by either of the two companies, power is given to one of Her Majesty's Principal Secretaries of State on application, and after due inquiry to make such order, subject to the provisions of the Act, as he thinks fit, but in making such order the Secretary of State is to have regard to the funds shown to be at the disposal of the Conservancy Board.

It appears, therefore, to the Board of Trade that the position of the Conservancy Board is this, that while, as trustees, they may be called upon to take legal proceedings to preserve the purity of the water, and a special contribution of £1,000 per annum is levied upon the two companies for that purpose, the Conservancy Board cannot be compelled to take these proceedings unless, having regard to the funds shown to be at their disposal, a Secretary of State thinks fit to order them to do so.

The insufficiency of the Conservancy Funds is, therefore, a ground for urging the Secretary of State not to order them to take proceedings under the Act of 1868, or a reason for requiring a larger contibution than £1,000 a year, rather than a ground for requiring the Board of Trade to take action under Section 9 of the Act of 1854.

Moreover, the provisions of that Section, even if still in force, do not go to the root of the matter. The Board of Trade are advised that the only issue which could be raised at an inquiry under that Section would apparently be whether or not the Hertford sewage is discharged into the Manifold Ditch without being subjected to purification by means of the best practicable process now known.

Mr. C. C. Hutchinson, Mr. G. Coble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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The question of the impurity of the effluent water, on which the Conservancy naturally lay great stress, could hardly come within the purview of the inquiry. It does not follow that the best known practicable process will ensure the absolute purity of the effluent, but having subjected it to that process, the Hertford Corporation would appear to be in their right in discharging the effluent, whether pure or impure, into the Manifold Ditch.

Again, the inquiry would doubtless involve the evidence of scientific experts, entailing heavy expense, the burden of which, if the Conservancy failed for the second time to prove non-compliance with the Act, might, and probably would, fall upon themselves. The Board of Trade desire to commend this contingency to the serious consideration of the Conservancy.

A further important consideration remains. It is contended by the Conservancy that "no chemical process alone, without ultimate filtration through sufficient and suitable land, can be effective, or be considered the best known process." Having regard to the language of Section 9, that contention raises the question whether any other than a chemical process is contemplated by the Act. This is a question of law, and there is the risk that, after the great cost of an inquiry has been incurred, the validity of the proceedings or of the Board's decision might be challenged by the Corporation of Hertford, and further costs be involved with the possible result that the inquiry might be held abortive, and the Conservancy be left precisely where they now stand.

The Board of Trade are anxious that the Conservancy should review their position in the light of any fresh consideration which may be suggested by this letter, and they will be glad to hear from you further in the matter. Meantime, the Board will invite the observations of the Hertford Corporation on the application of the Conservancy. I am, Sir,

The Clerk to the Lee Conservancy
12, Finsbury Circus, E.C.

Your obedient Servant,
(Signed) COURTENAY BOYLE.

This letter is important, as it puts, very clearly, the exact position of the Conservancy Board at the present time, and points out that an "Inquiry" would really mean a repetition of the trial of 1884.

Since 1896 the river has been getting worse and worse, and during the summers of 1901 and 1902, particularly owing to the shortness of water, the condition was alarming to the health of the inhabitants of the town of Ware, apart from the question of the effect of the pollution on the water supplied by the East London Water Works Company. Upon representation to the Company by the Conservancy that they should take the matter up in the interests of their water consumers, the former opened up negotiations with the Corporation, and finally took over the works on the 29th September, 1899.

Still the nuisance continued, and was the cause of many complaints by the Conservancy to the company.

On the 15th of May, 1902, the engineer of the company reported to his directors as follows:—

Copy of Engineer's Report upon Hertford Sewage.
May 15th, 1902.

To the Chairman and Court of Directors of the East London Waterworks Company.

With respect to the discussion by the Court of Directors on the 8th May *re* the delay in commencing the proposed new sewage purification works, I beg to call attention to the following:—

The Hertford Sewage Works were handed over to the company on September 29th, 1899. Early in October plans and general information were sought for from the Hertford Corporation. There were no plans existing, and early in November a detailed description was commenced of the state of the drains and culverts, and a general inspection of the sewage works, and all November was occupied in studying the conditions and treatment of the sewage. The surveys of the old works were completed by the end of the year. Major Flower had brought forward a scheme for purifying the Hertford sewage by using land below Ware. This scheme was carefully examined. Surveys had to be made and levels taken, with the result that it was found that the scheme was utterly impracticable, owing to the whole of the levels being inaccurate, and the actual outfall in the Manifold Ditch as compared to the land at Ware being 10ft. too low. Alternative schemes were considered as to using land belonging to the New River Company lying between the Manifold Ditch and the Great Eastern Railway. In each case, however, it was thought that there were so many objections that they were abandoned.

Mr. W. J. Dibdin, the chemist specialist engaged by the company, who had visited the sites, quite agreed with my disapproval of the two schemes. On February 8th, 1900, Mr. Dibdin met myself and assistant at St. Helens Place, and all facts ascertained about the sewage works were put before him. He visited the Hertford works on February 16th, and examined the lands in the neighbourhood, and he most strongly advised the purchase of the fields adjoining the works for the new extensions. Very great delay occurred before the two fields could be acquired, as the solicitors to both parties could not settle a clause which would make it perfectly clear that the land when purchased for the company could be used for sewage works.

The volume of sewage per head per day passing through the old works was so excessive that it was quite clear that to deal with the sewage in as effectual a manner as was desired, it would be necessary either to reduce this volume of sewage, or to acquire at some point within the valley of the Lee other lands on which to construct works of sufficient capacity. Before doing this it was desirable to set about gauging the water in the sewers of the town, so as to ascertain the possibility of effecting a material diminution of the quantity without completely relaying the whole of the sewers. On March 6th the Borough Surveyor was consulted for the purpose of obtaining permission for gauges to be fixed in the sewers, and he agreed to this, but, after two months' delay, my assistant took the matter up, and worked at this problem without intermission for many months.

On March 8th Mr. Dibdin was again consulted with respect to the magnitude of the new works, and he considered the steps we had commenced *re* the excessive volume of sewage by infiltration as absolutely necessary. On March 23rd Messrs. Savill were interviewed *re* purchase of land. On April 11th Mr. Dibdin sent in a draft scheme of proposed bacteria beds to treat the whole of the sewage. In the middle of April a recording clockwork gauge was placed at the sewage works, and has been in operation ever since. My assistant had to make plans of the sewers of Hertford from what data he was able to get from the Borough Surveyor, and meanwhile the gauges in some of the sewers had been fixed, and on May 27th the gaugings were started and continued to the 25th September without intermission, the gaugings being taken three times daily. More than a thousand gaugings had to be separately worked out and tabulated.

After much negotiation the land purchase was finally effected, and by September the company obtained possession by compensating the tenant. The surveys and levels of the two fields were immediately commenced, and occupied most of the month. The sewer gaugings, which have occupied so many months, proved conclusively that a huge body of infiltration was taking place, and the principal places were located. The matter was reported to you, and the expenditure of a considerable sum of money sanctioned for putting down sewers in lieu of the leaky ones. Immediately after your sanction was obtained negotiations were opened with Hertford. It was necessary that sewers should be laid under the Great Northern Railway. The Hertford Corporation, having power to serve notices under the Public Health Act, were asked to do so. These notices, and the expiration of the proper time before executing the work, occupied some weeks. There was also a considerable period taken up in negotiations between the various solicitors in arranging terms for making new sewers in North Road and across Hartham Mead.

July 13th to October 15th was occupied in relaying sewers across Hartham Mead under the supervision of my assistant, and the North Road sewer was finished by November 15th, under the supervision of the Borough Surveyor. The results were, as already reported to you, a diminution in the volume of sewage of about one half. Certain other sections of sewers should also be dealt with in a similar manner, so as to reduce the dry weather flow to 400,000 gallons a day, and on this basis the designs have been got out. The whole of the other designs for dealing with the volume of sewage met with at the works when taken over by the company would have necessitated a special Act of Parliament, as such a volume could not have been dealt with anywhere in the neighbourhood of the existing sewage works.

The area of the bacteria beds now proposed is only one-third of that of the original scheme.

The whole of this year from January to the end of

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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April has been occupied in drawing out all details connected with the scheme, and not a moment of time has been lost, seeing that the construction of the works involved the design of a very large plant of automatic apparatus, which alone involved more than 50 sets of drawings.

I would point out also that at the end of 1900 the Hertford Corporation gave permission for the refuse of the Horns Mill Tannery to be sent into the public sewers, with the immediate result of upsetting the whole treatment, and also, supposing the Tannery Company had a legal right to turn in their refuse, the reconstruction of the whole scheme which had taken so many months' labour to prepare.

I think, therefore, although a long period has elapsed since the taking over the works, that the time has been most profitably employed, and, while considerable delays have occurred in settling terms of various agreements, such delays are difficult to avoid when clauses of great importance have to be settled.

(Signed) William B. Bryan, Engineer.

In July, 1902, the Conservancy took the opinion of counsel as to their position, upon which,

After a lengthened consideration of the matter,

It was Resolved:

> That an application be made to the Board of Trade, under Sections 8 and 9 of the "Hertford Sewage Diversion Act, 1854," for a declaration as to what is the best known practicable process to which sewage or sewage water flowing from the sewers or drains, by the said Act of 1854 authorised, ought to be subjected before flowing mediately or immediately into any part of the River Lee or of the River Lee Navigation.

It was also Resolved.

> That a notice, under the Act of 1900, be served on the Hertford Corporation with respect to the pollution caused to the river below Ware Lock by the discharge into the Manifold Ditch of the effluent from the Hertford Sewage Works.

On the 7th August, 1902, application was made to the Board of Trade accordingly.

During November and December, 1902, differences of opinion arose between the Conservancy and the company as to the cause of the foul condition of the navigation from Ware Lock down to Stanstead, and various reports were made. The company called in independent chemical assistance. The company said it was *not* the Hertford effluent which caused the nuisance. On the 18th November the Conservators, with the representatives of the company, inspected the river.

In answer to the application of the Conservancy to the Board, the following was received:—

"Board of Trade
"(Fisheries and Harbour Department),
"7, Whitehall Gardens,
"London, S.W.
"22nd November, 1902.

"Sir,—I am directed by the Board of Trade to advert to your letter of the 7th August last, making application on behalf of the Lee Conservancy Board, under the provisions of Section 9 of the New River Company's (Hertford Sewerage Diversion) Act, 1854, for a declaration of what, in the opinion of the Board, is the best known practicable process to which sewage or sewage water flowing from the sewers or drains authorised by that Act ought to be subjected before flowing mediately or immediately into any part of the River Lee or of the River Lee navigation.

"The Board of Trade desire to call the attention of the Lee Conservancy Board to the observations contained in the letter from this Board on the 31st December, 1896, with regard to the necessity or propriety of proceedings under the Section referred to, and to point out that at the present time a Royal Commission is sitting to inquire and report what methods of treating and disposing of sewage may properly be adopted, and that this appears to be in the main the question which the Lee Conservancy Board ask the Board of Trade to determine.

"The Board of Trade have communicated with the Hertford Corporation in the matter, and are informed by them 'that they have now under their immediate consideration a scheme for the reconstruction of their sewage works and the purification of the effluent, involving the estimated outlay of a large sum, which operation they are undertaking in conjunction with the East London Waterworks Company, and which scheme they have every reason to believe will remove the cause of complaint, if any such now exists, which the Corporation must not be taken to admit,' and that application will shortly be made to the Local Government Board for an inquiry for the purpose of obtaining the sanction of that Department to a loan for the proposed new works.

"In these circumstances the Board of Trade, as at present advised, are doubtful whether they can usefully take action in the matter, but they will confer with the Local Government Board on the subject when the inquiry into the scheme proposed by the Hertford Corporation has been held.

"I am, Sir, your obedient servant,
"(Signed) T. H. W. Pelham.

"The Clerk to the Lee Conservancy Board,
12, Finsbury Circus, E.C."

Extracts from Minutes of Lee Conservancy Board, dated 6th February, 1903.

Hertford Sewage. Local Government Board.

Reported that a notice had been received stating that an inquiry would be held at the Shire Hall, Hertford, on Tuesday, the 10th day of February, 1903, at 11 a.m., by Colonel W. R. Slacke, R.E., on the application of the Hertford Corporation to borrow £27,000 for the purpose of sewerage and sewage disposal (including the execution of works in the urban district of Ware), and £716 for other works.

Upon a full consideration of the question, on the proposition of Mr. Bellsham, seconded by Mr. Nield,

It was Resolved:

> That the scheme be strongly opposed by the Conservancy Board on the following grounds, and that Mr. C. C. Hutchinson be engaged as counsel on behalf of the Board at the inquiry, namely:—
>
> That in the opinion of this Board no scheme will effectively remove the pollution caused to the river below Ware Lock by the influx of the effluent from the Hertford Sewage Works, or prevent possible future contamination to the drinking water supplied to London which does not provide for the carrying away of the sewage water out of the district.
>
> That looking to the fact that the new Water Board now being elected under the provisions of the "Metropolis Water Act, 1902," will have to take this matter into their consideration, it is desirable that the expenditure of £27,000, as proposed, should be postponed for a time.
>
> That at the inquiry the consideration of the inspector be directed to the position of the Conservancy with regard to their applications made to the Board of Trade and the Local Government Board last year, as to the "best known practical process" to be used for the purification of the Hertford sewage, in compliance with the provisions of the "Hertford Sewerage Diversion Act, 1854."

At the Local Government inquiry, held at Hertford on the 10th February, 1903, Mr. C. C. Hutchinson, as counsel for the Conservancy, after referring to the Report of the Royal Commission on Metropolitan Water Supply, 1893 (p. 70, para. 175), stated as follows:—

"That was the starting point of this inquiry, and since that Commission a good deal of water in that polluted condition had gone down the River Lee, and had been consumed by the inhabitants of London. Considering that the Lee supplied about one-third of the whole of the Metropolitan Water Supply, could there be any measure too stringent or too costly to conserve the purity of that water? The inspector was not in this inquiry discharging the ordinary functions of such inquiries, but would have to declare to the Local Government Board whether, in his opinion, this was the best known practical process. He thought this was too serious a matter to determine by such a brief inquiry, especially as a Royal Commission was now sitting to determine this subject."

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

20 Oct. 1903.

Extract from Minutes of Lee Conservancy Board, dated 26th June, 1903.

ROYAL COMMISSION ON SEWAGE. HERTFORD SEWAGE.

On the motion of Mr. Barnard

It was Resolved:

That the Board do consider it advisable to approach the Royal Commission on Sewage Disposal, now sitting, as to the proper disposal of the Hertford sewage, and generally as to the disposal of the sewage of the Lee Valley, and that they be asked to hear evidence from the Board thereon.

The following letter was read, viz.:—

"Local Government Board,
"Whitehall, S.W., 3rd July, 1903.

"SIR,—I am directed by the Local Government Board to acknowledge the receipt of your letter of the 18th ultimo, with reference to the application which has been made to them by the Town Council of Hertford for sanction to borrow money for the extension of their sewage works.

"I am to refer to the provisions of Sections VIII. and IX. of the New River Company's (Hertford Sewerage Diversion) Act, 1854, under which any questions which may arise as to what is the best known practicable process for the purification of the Hertford sewerage are to be determined by the Board of Trade, and to state that, looking to those provisions, the Local Government Board, as at present advised, consider that they should defer coming to a decision on the application of the Town Council for sanction to a loan for works for the treatment of the sewage until the Board of Trade have determined what is the best known practicable process. The Board have, therefore, been in communication with that department on the subject, and it is hoped that the matter will be referred to the Royal Commission now sitting to inquire and report what methods of treating and disposing of sewage may be properly adopted.

"I am, Sir, your obedient servant,
(Signed) "H. C. MONRO,
"Assistant Secretary.

"The Clerk to the Lee Conservancy Board."

Minute, 11th September, 1903.

The following letter was read, viz.:—

"Board of Trade
(Fisheries and Harbour Depart.),
"7, Whitehall Gardens, London, S.W.
"5th August, 1903.

"HERTFORD SEWAGE.

SIR,—I am directed by the Board of Trade to advert to your letter of the 1st ultimo with reference to the application made to them by the Lee Conservancy Board under the provisions of Section 9 of the New River Company's Hertford Sewage Diversion) Act, 1854.

"I am to inform you that, in connection with the application by the Hertford Corporation for the sanction of the Local Government Board to a loan for the purpose of carrying out the proposed scheme for the disposal of the sewage of Hertford, that Department has suggested to the Board of Trade that it would be desirable that the Board should request the Royal Commission on Sewage Disposal to consider the proposed scheme, and to state whether, in their opinion, the system proposed can be regarded as 'the best now known practicable process' to which the sewage of Hertford ought to be subjected in compliance with the provisions of Section 8 of the New River Company's (Hertford Sewerage Diversion) Act, 1854.

"In these circumstances, I am to inquire whether your letter of the 1st ultimo is intended to be regarded as a withdrawal of the application to this Department, or whether the Lee Conservancy Board merely desire a postponement of the consideration of the matter.

"I am, Sir, your obedient servant,
(Signed) "WALTER J. HOWELL.

"The Clerk to the Lee Conservancy Board."

"H. 10559.

"Lee Conservancy, 12, Finsbury Circus, E.C.,
"12th August, 1903.

"HERTFORD SEWAGE.

"DEAR SIR,—In answer to your letter of the 5th inst., I am directed by the Lee Conservancy Board to say that they do not wish to withdraw the application made by their letter of the 1st ultimo, but to have the question postponed for further consideration, possibly by the Royal Commission on Sewage Disposal.

"I also beg to inform you that the Commission have intimated to the Conservancy Board that they will be prepared to receive evidence from the Conservancy on the following points, namely:—

"(a) The constitution of the Board.

"(b) The nature and scope of the powers of the Lee Conservancy in regard to pollution and the protection of water supplies.

"(c) The method of work adopted by the Conservancy for the detection and prevention of pollution.

"(d) The reasons why separate action on the part of the several local authorities has been unsuccessful; and

"(e) What alteration in the law the Conservancy consider desirable for the prevention of pollution of water supplies.

"Although the Commission have specified these points, they direct me to say that they do not desire to exclude evidence on any other matters in connection with the prevention of pollution and the protection of water supplies which the Conservancy think should be included.

"I am, Sir, your obedient servant,
(Signed) "GEORGE CORBLE,
"Clerk.

"The Assistant Secretary,
"Fishery and Harbour Department,
"Board of Trade,
"7, Whitehall Gardens, S.W."

INTAKES OF WATER COMPANIES.

POLLUTIONS ABOVE AND BELOW.

The intake of the New River Company from the River Lee is at the "Balance Engine," midway between Hertford and Ware, about a mile above Ware Lock.

The effluent from the Hertford sewage is discharged into the River Lee Navigation through the Manifold Ditch, a few yards below the tail of Ware Lock. This does *not* affect the water drawn from the River Lee by the New River Company.

The intake of the East London Waterworks Company is from the Navigation at Kied's Weir, about 200 yards below Ponders End Lock, 16 miles below the intake of the New River Company, and 11 miles above the entrance of the River Lee Navigation to the Thames at Limehouse.

The sewage effluents of the various places above the town of Hertford and the district of the River Rib (a tributary), as shown on the map, affect the supply of the New River Company.

The foregoing, with the towns and places below, including the Rivers Stort and Ash Districts, affect the supply of the East London Waterworks Company.

Under the East London Waterworks Act, 1853, the Company constructed at their own cost an open drain or channel, called the "Intercepting Drain," to divert the sewage of the districts of Enfield, Ponders End, Edmonton, and Tottenham, from above their intake. This drain discharges into the Navigation a few yards below Tottenham Lock.

It now receives the sewage effluents from Cheshunt, Enfield, and Edmonton. These do *not* affect the East London Company's supply.

The discharges from the sewage works of Waltham Abbey, and the pollutions which are being continually turned in from the Royal Gunpowder Works, Waltham Abbey, are about three miles above the East London intake.

At the Royal Small Arms Factory, Enfield Lock, two miles above the intake, there is a day population of some

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4,000 workmen. The sewage is dealt with on land which is liable to floods.

As before shown, both the New River and East London Water Companies have expended large sums in carrying out works having for their object the removal of sources of pollution to their water supply.

Floods.—During the present year (1903) the whole of the Lee Valley has been visited by heavy floods, and all the contents of the sewage farms and the effluents generally have been washed into the river. This is liable to recur.

Between Hertford and Ware the New River, Lee Navigation, and Manifold Ditch (full of Hertford sewage) were on a common level.

26th June, 1903. Engineer's Report.

"Bishops Stortford Sewage Farm. Pumping was continued during the flood. Farm covered with water and sewage, disposed of as best they could. During such exceptional floods, when the boiler fires are extinguished, the local authorities have no alternative."

The whole of the valley was in flood again on the 12th October, 1903, and likely to continue for some days.

The Conservancy would again emphasise the necessity of a Main Lee Valley Sewer being constructed to prevent a repetition of this chance of dangerous pollution to the river.

The following extracts from the reports of the Analytical Chemist of the Conservancy show clearly that, however much care may be taken by the local authorities in the management of their sewage works, frequent pollutions *do* occur, accidents happen, the results vary, and it requires a constant police supervision to detect these delinquencies.

Following these reports, the Conservancy have instituted several prosecutions, and certain better results have been obtained in most of the cases, but there still remains the chances of these occasional pollutions.

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REPORTS of Mr. *W. C. Young*, F.I.C., F.C.S., the Chemist of the Conservancy Board, on Samples of Sewage Effluents from various Towns and Places in the Lee Valley.

NOTE.—Detailed Analyses accompanied each Report.

DATE.	TOWN OR PLACE.	REPORT.
1901:		
25th June -	Hertford - - -	It was not a desirable liquid to discharge into the river, being highly charged with nitrogenous organic matter, and rapidly became putrid and offensive.
25th July -	Cheshunt - - -	This was a sample of partially clarified sewage water, which, when separated from the deposit, was rapidly becoming purified by oxidation. It was quite unfit for discharge into water, forming a source for a drinking supply, but apart from the suspended matter, would be inoffensive and non-injurious if turned into a stream not used for drinking. The suspended matter however, although small, is distinctly objectionable.
31st July -	London County Council. Storm Water Outfall. Old Ford.	This sample was crude sewage, very strong in fœcal matter, and extremely offensive. It was the strongest sample of sewage matter I have ever examined. Its discharge into the Bow River must inevitably cause serious nuisance; and as the suspended matter would be deposited in the near vicinity of the outfall, the river in that locality would be fouled for a very long period by the decomposition of the fœcal matter so deposited, even if nothing further were discharged from the outfall.
2nd Aug. -	War Department, Enfield Lock.	It is evident from the acidity of the water after boiling (the normal river water being alkaline after boiling) the increase in sulphates, the increase in the total and permanent hardness, and the increase in the nitrates, as compared with the normal river water, that a very large addition of free sulphuric and nitric acids must have taken place to the river water at some point above that at which the sample was taken. This is a very serious pollution, and quite sufficient to account for the killing of fish in the river. There is also some indication of sewage pollution. and the condition of the water is such as to render it quite unfit for drinking.
12th Aug. -	Bishops Stortford -	The water gives evidence of serious recent pollution by sewage, and is quite unfit for drinking.
15th Aug. -	Bishops Stortford -	The water is crude sewage, giving little evidence of treatment by any method, in a foul and putrid condition, and quite unfit to be discharged into any open water-course, being offensive and injurious.
28th Sept. -	Cheshunt - - -	The sample was partially purified sewage water unfit for discharge into a stream forming a source of drinking supply, but being in a state of active purification by oxidation would be unobjectionable in any other water-course. The sample was a great improvement upon that taken at the same place on the 25th July, the suspended matter being less in quantity and free from fœcal matter.
7th Oct. -	Bishops Stortford -	The sample was weak sewage water quite unfit to be discharged into any stream from which water for drinking is taken, but not sufficiently polluted to give rise to offensive odour or to cause any serious discolouration.
28th Nov. -	Welwyn - - -	Sample No. 1 was sewage water, partially clarified, in a putrescent condition, and quite unfit to be discharged into any open water-course.
3rd Dec. -	Bishops Stortford -	The sample was weak sewage in a highly putrescent condition, and quite unfit to be discharged into any open water-course.
1902:		
28th Jan. -	Enfield - - -	The sample was sewage water, giving little evidence of having passed through land, and in such a condition as to render it quite unfit to be discharged into any open water-course.
5th Feb. -	Cheshunt - - -	The sample was sewage water, giving no evidence of having passed through land, and in a state quite unfit to be discharged into any open water-course.
4th March -	Walkern - - -	The sample was sewage water, in a foul and putrescent condition—quite unfit to be discharged into any open water-course.

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Reports of Mr. *W. C. Young*, F.I.C., F.C.S. on samples of Sewage Effluents, &c.—*continued.*

DATE.	TOWN OR PLACE.	REPORT.
1902:		
5th March	Hertford. - - -	This was a sample of weak sewage water, similar, except for the small quantity of suspended matter, to previous samples from the same place. Although the suspended matter was very small in amount, it was of a very foul character, and similar to that found in previous samples. The sample was of such a character as to be unfit to be discharged into the river at that point.
6th March -	Edmonton - - -	The sample was sewage water, giving no evidence of effective land treatment, and being in a foul and putrescent condition was quite unfit to be discharged into any open water-course.
14th March -	Edmonton - - -	The sample was sewage water, giving no evidence of effective land treatment, and being in a highly putrescent condition, was unfit to be discharged into any open water-course.
17th March -	Cheshunt - - -	The sample was sewage water, giving no indication of effective land treatment, and unfit to be discharged into any open water-course.
27th March -	Wormley - - -	The sample is sewage water in a foul and putrescent condition, giving no evidence of having been subjected to efficient land treatment, and quite unfit to be discharged into any open water-course.
1st April -	Leyton - - -	The sample gave abundant evidence of efficient chemical treatment, and was undergoing rapid oxidation, and improving in condition every hour. The deposit, or suspended matter, although small, indicated that insufficient time had been given for perfect subsidence in the tanks; but with this exception, I consider the effluent very satisfactory.
1st April -	Walthamstow - -	This sample was most unsatisfactory; it was in a foul and putrescent condition, and certain to discolour and cause offensive odour in any stream into which it was discharged.
4th April -	Hadham - - -	The sample was very strong sewage water in a putrid and foul condition, and quite unfit to be discharged into any open water-course.
3rd May -	Hoddesdon - - -	The sample was sewage water in a very foul and putrid condition, and quite unfit to be discharged into any open water-course.
14th May -	Channelsea River. -	The results show that it is weak sewage water, slightly putrid, and in such a condition that in warm weather would become very offensive.
15th May -	Stapleford - - -	The sample was crude sewage water in a very foul and putrid condition, and quite unfit to be discharged into any open water-course.
2nd June -	Cheshunt - -	The sample was sewage water in a very foul and putrid condition, and quite unfit to be discharged into any open water-course.
7th June -	Hertford. - - -	The sample was very turbid, neutral, had a strong sewage odour, brown tinge (after separation of the suspended matter), and contained a large foul smelling black deposit consisting largely of putrid sewage fungus.
19th June -	Edmonton - - -	The sample, although much polluted with sewage, and far below the standard of good effluents from sewage farms, gave no indication of any tendency to putrefactive change, and as active oxidation of the organic matter was progressing slowly, I do not think that it would be likely to give rise to offensive odour or cause any serious discolouration in the river on its discharge.
2nd July -	Hertford - - -	The sample when received was slightly turbid, neutral, had a brown tinge, a slight sewage odour, and contained a small grey deposit, consisting mainly of sewage fungus, swarming with infusoria.
4th July -	Channelsea River. -	The sample was strongly polluted with sewage in a putrid and foul condition, and certain to cause nuisance injurious to health. In fact, as regards foulness of odour and appearance, it was as bad as crude sewage.
11th July -	Enfield - - -	This sample was strong sewage water, bearing no evidence of having been subjected to efficient land treatment. It was certain to cause discolouration, and likely to give rise to offensive odour if discharged into the Lee.

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Reports of Mr. *W. C. Young*, F.I.C., F.C.S., on Samples of Sewage Effluents, &c.—*continued.*

DATE.	TOWN OR PLACE.	REPORT.
1902:		
17th July	Channelsea River	The sample was rather weak sewage water in putrid and foul condition, and certain to cause nuisance injurious to health.
19th July	Hertford	The sample was weak sewage water in a putrid and foul condition, and quite unfit to be discharged into the Lee, or, indeed, into any open water-course.
23rd July	Hertford	The sample was weak sewage water in a putrid and foul condition, and quite unfit to be discharged into the Lee.
25th July	Leyton	The sample was strong sewage water in a highly putrescent condition, and rapidly became putrid and extremely offensive. Such a liquid, if discharged into any open water-course, would be sure to give rise to offensive effluvium injurious to health.
26th July	Walthamstow	The sample was moderately strong sewage water in a putrid and offensive condition, and quite unfit to be discharged into any open water-course, as it would certainly give rise to an offensive effluvium injurious to health, and discolour the water it flowed into.
28th July	Leyton	The sample gives abundant evidence of having been efficiently treated by chemical means, and as it gives no indication of any tendency towards putrefactive change, but improves in condition on keeping, I do not think that it is likely to give rise to offensive odour, or to cause discolouration of the water of any stream into which it is discharged. If, however, the water into which it is discharged is putrid, then it would soon become putrid itself, and cause offensive odour and discolouration.
1st Sept.	Channelsea River	This sample, which was largely Thames water, was seriously contaminated with sewage water, but as it gave no sign of any tendency towards putrefactive change, and become quite inoffensive on keeping, I do not think it at all likely to give rise to offensive effluvium on its passage down.
1st Sept.	Leyton	This sample was fairly satisfactory, and gave abundant evidence of having been submitted to efficient chemical treatment. It would, however, have been much improved by longer or more perfect subsidence.
1st Sept	Wormley	This was a sample of weak sewage water in a putrid and foul condition, and quite unfit to be discharged into any open water-course.
5th Sept.	Walthamstow	This sample was weak sewage water in a putrid and foul condition, and quite unfit to be discharged into any open water-course.
25th Sept.	Enfield	This sample was sewage water, which had remained stagnant for some time. It was in a putrescent condition, and rapidly became offensive. It was quite unfit to be discharged into any open water-course.
26th Sept.	Wormley	This sample was rather weak sewage water, which had been treated with lime, but gave no indication of having been subjected to efficient treatment through land. It was slightly putrescent, and would therefore slowly decompose and become offensive. It was quite unfit to be discharged into any open water-course.
29th Sept.	Waltham Abbey	This sample was weak sewage water in a highly putrescent and foul condition, and quite unfit to be discharged into any open water-course. It had been treated with lime, but gave no indication of having been subjected to efficient treatment through land.
23rd Oct.	Welwyn	This sample was rather weak crude sewage, from which the heavier particles of suspended matter had been removed, in a highly putrescent condition. It was quite unfit to be discharged into any open water-course, its condition being such as would certainly give rise to offensive effluvium injurious to health, and to cause discolouration of the stream receiving it.
27th Oct.	Walkern	The sample was rather weak sewage water in a putrescent and foul condition. It was quite unfit to be discharged into any open water-course, being certain to give rise to offensive odours injurious to health, and to cause discolouration of any stream into which it may flow.

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Reports of Mr. *W. C. Young*, F.I.C., F.C.S., on Samples of Sewage Effluents, &c.—*continued.*

DATE.	TOWN OR PLACE.	REPORT.
1902:		
5th Dec.	Walthamstow	This sample, as received, was in a fairly satisfactory condition, and at the prevailing outdoor temperature would not deteriorate or cause any discolouration or other objectionable feature in the Leyton Level brook or the Channelsea. There was, however, little real improvement as compared with former samples from the same outfall, as at moderate temperatures the sample rapidly became putrid and offensive.
1903:		
5th Jan.	Waltham Abbey	This was a sample of weak sewage water in a very unsatisfactory condition, and quite unfit to be discharged into any open water-course. Its condition shows a slight improvement upon that of the sample taken on the 29th September last, but this may be due to its dilution.
21st Jan.	Cheshunt	This was a sample of weak sewage water in a slightly putrid and offensive condition, and therefore quite unfit to be discharged into any open water-course. Some ineffectual attempt at disinfection appears to have been made in this case by means of cresote or a preparation of cresote or tar oils.
22nd Jan.	Edmonton	This was a sample of weak sewage water, which gave evidence of partial putrefaction, and if discharged into a fair volume of fresh water would, in my opinion, be unobjectionable. Left to itself it slowly deteriorated, and became slightly putrid and offensive.
23rd Jan.	Enfield	This sample was sewage water in a putrid and extremely foul condition, and quite unfit to be discharged into any open water-course.
24th Jan.	Stapleford	This sample was strong crude sewage in a putrid and extremely foul condition, and quite unfit to be discharged into any open water-course.
16th Feb.	Cheshunt	This sample was a great improvement on the previous one. It gave evidence of having been subjected to land treatment, and as active oxidation of the polluting matter was in progress, and its condition improved on keeping, I am of opinion that, although it was not a good specimen of an effluent produced by land treatment, its condition was such as would not be likely to cause discolouration of, or offensive odour from, any ordinary stream into which it may be discharged.
13th March	Welwyn	This was weak sewage water in a highly putrescent condition, and rapidly became putrid and foul. It was quite unfit to be discharged into the Mimram, being certain to cause discolouration, and to give rise to offensive odour.
27th March	Hertford Heath	This is sewage water containing something which effectively retards its putrefaction. Under existing conditions of temperature it is unlikely to become offensive, but in hot weather such an effluent may become putrid and very objectionable. It is quite unfit to be discharged into any stream forming a source of drinking water supply, and its turbidity and general character renders it unsuitable for discharge into any open water-course.
17th April	Edmonton	This was sewage in a putrid and extremely foul condition, and quite unfit to be discharged into any open water-course.
1st May	Waltham Abbey	This was rather weak, stale sewage water, extremely objectionable in appearance. It slowly became putrid and rather offensive, and was altogether of such a character as to be unfit to be discharged into any open water-course.
30th July	Royal Gunpowder Mills, Waltham Abbey.	No. I., from No. 2 pipe, was seriously polluted with vegetable organic matter, and contained a quantity of black suspended matter, sufficient to make the whole sample black when shaken up. It was therefore quite unfit to be discharged into the brook. No. II., from No. 5 pipe, was acid, with nitric and nitrous acids, and would be injurious, perhaps fatal, to fish. It was quite unfit to be discharged into the brook. No. III., from No. 7 pipe, was very acid with sulphuric, nitric, and hydrochloric acids, and would be fatal to fish, and seriously affect the quality of the water, and its suitability for drinking and domestic purposes. It was quite unfit to be discharged into the brook.

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Reports of Mr. *W.C. Young*, F.I.C., F.C.S., on Samples of Sewage Effluents, &c.—*continued.*

DATE.	TOWN OR PLACE.	REPORT.
27th July -	Royal Gunpowder Mills, Waltham Abbey.	Sample 4 contained a notable proportion of vegetable organic matter in solution, and was therefore unfit to be discharged into the brook. Sample 5 was slightly acid with nitrous acid and contained a considerable proportion of vegetable organic matter in solution. It also was unfit to be discharged into the brook. Sample 6 contained a small quantity of vegetable organic matter in solution, and gave signs of a tendency to become putrid. It was, therefore, unfit to be discharged into the brook. Sample 7 contained a small quantity of vegetable organic matter in solution, and in addition five grains per gallon of guncotton in suspension. This means that for every 100 gallons of such liquid about 1¼ ounces of guncotton would be discharged, and although this would all dissappear from the water before it left the water works, it appears to me to be a very improper substance to be discharged into the brook. Apart from this, the organic matter in solution renders this sample unfit to be discharged at this point.
6th Oct. -	Powder Mills, Waltham Abbey.	This sample was largely polluted by the refuse from some manufacturing operation, and on account of its turbidity, colour, and the large quantity of dissolved organic matter and alkaline salts present, quite unfit to be discharged into the river at any point, and particularly above the intake of the Water Company.
9th Oct. -	Waltham Abbey - -	This was a sample of weak sewage water which had been deodorised and partially purified. It gave no indication of any tendency toward putrifactive change, and as the polluting matter was undergoing natural oxidation, I am of opinion that its discharge into the Lee would not give rise to offensive odour from the river or cause discolouration of the water. It was, however, insufficiently purified to justify its discharge above the intake of the Water Company.

THE METHOD OF WORK ADOPTED BY THE CONSERVANCY, ETC.

Immediately on the passing of the 1868 Act, and the Board coming into office in April, 1869, notices were served on all the principal towns, villages, places, persons, etc., in the watershed of the Lee, directing them to discontinue discharging sewage into the river. Up to that time hardly a town or place had any proper system of sewerage. In many instances it was turned direct into the river. Thereupon several of the larger towns set to work to carry out sewerage schemes, some adopting the land, and others tanks and chemical processes.

The Conservancy extended the notices from time to time to enable these works to be carried out. In some cases it took three or four years to complete, and in the meantime, of course, the pollution of the river continued.

After the various works had been in operation for a reasonable period the Board found in many instances that the results were far from satisfactory, and in several instances prosecutions were taken before the local magistrates under the Act of 1868, but convictions were rarely obtained, as the sympathy was naturally on the side of the local authority.

In 1872 the Board appointed as their Sanitary Engineer Major L. Flower, to superintend and look after the whole of the watershed. One of the Board's toll collectors in the lower end of the river was appointed water bailiff in his particular district.

In his evidence on the Conservancy Bill of 1900 Major Flower stated as follows:—

> "I am a Consulting Engineer, and hold the official position of Sanitary Engineer to the Lee Conservancy Board, to which I was appointed in 1871. My duty is to prevent pollution to the River Lee and its tributaries, the area of which extends over 600 square miles.
>
> "I have paid special attention to sanitary matters generally, and to prevention of river pollution.
>
> "I am of opinion that the sum provided for protection of water purposes by the Lee Conservancy Act, 1868, is totally inadequate; that the subject has been taken in hand upon too penurious a scale, and that the £3,000 which was suggested in the Bill of 1868 would be none too much for the duty, looking to the large increase of population in the watershed, and considering the importance of preventing pollution to an area from which water supply is drawn, which was not properly appreciated 30 years ago, independently of the public health question. Pp. 205 and 2,814 to 2,817, 'Select Committee River Lee,' Bryan's evidence.)
>
> "Very early in my service I made application to the Lee Conservancy Board for an assistant; this was declined from want of means, and for 27 years I carried on the duty entirely alone, with the exception of a bailiff, who was also employed to regulate traffic at the lower end of the river, and also to see to abatement of pollution, a mixed duty which was not satisfactory, for duties pertaining to navigation work and protection of water should be separate entirely, as they are apt to clash.
>
> "I do not consider prosecutions advisable, unless under special circumstances, and that if the duty had not been carried on as it has been the work would have been impossible.
>
> "That it is impossible for any one man to satisfactorily watch such a large area as the watershed of the Lee, man being neither omnipotent nor omnipresent; the Board, therefore, being pressed by the East London Water Company, decided to re-arrange the details of the appropriation of the £1,000—the maximum sum provided by the Act—and appointed another man to assist me in patrolling the area and examining the sewage works and sewage farms.
>
> "These men are styled 'water bailiffs,' and the result of their work is valuable in the extreme; more inspection in detail is needed, but the funds as at present arranged are inadequate.
>
> "That, in my opinion, at least four water bailiffs are necessary; for although in every known case of pollution by local authorities a remedy has been attempted, all cases are not satisfactorily dealt with, and require constant supervision to keep the local authorities up to their duty.
>
> "That it is necessary to have skilled supervision of the details of inspection, both to secure satisfactory results and to see that the policy of persuasion rather than persecution be adhered to; long experience has taught me the value of this procedure, which I have always adopted. In my judgment, money should be provided for legal proceedings in doubtful cases only; in order to do this more money is necessary, and this only supplies funds for inspection of the area, and is in no sense

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to include scavenging or cleansing the streams. The sum proposed—£2,000—is somewhat more in proportion to the value of the duty than the £1,000 at present provided.

"It is also necessary to have a perfect systematic series of samples and analyses; I proposed at one time to have a laboratory established for this purpose, but no means were available for analyses; thus, further money is necessary."

About three years ago the Conservancy appointed another man to assist Major Flower in his work.

Since the death of Major Flower (in May, 1901), who held the separate appointment of Sanitary Engineer, the Conservancy have combined the duties of the Navigation Engineer Mr. Tween for that purpose, with necessary assistance. The general correspondence of the protection of water business is conducted by the Clerk of the Board.

Mr. W. G. Young, F.I.C., F.C.S., has acted as Analytical Chemist for the Board during the last 25 years.

Since 1901 the Board have appointed an extra water bailiff, making three in all, whose sole duty it is, under the direction of the present Engineer, Mr. C. N. Tween, to patrol the watershed, and keep watch and inspection on all the sewage works, sewage systems, and manure barges used on the Lee, unloading refuse on the banks, and generally to devote their whole time to the duty of preventing pollution, and reporting thereon.

These reports are made daily, and the substance of them is submitted by the Engineer to the Conservancy at their fortnightly meetings, and such action taken thereon as may be deemed necessary. In addition to these men, every lock keeper on the Navigation has instructions to watch for any pollutions which may occur in his district, and to remove any dead animal or noisome thing from the river.

During the summer time two extra men are specially engaged with a boat in the work of scavenging the river, particularly the lower portion.

The number of carcases removed from the navigation in 1901 was 657, and from the old Lee, Hackney Marsh, and back streams 287.

From June 10th, 1901, to October 6th, 1903, between Tottenham, Hackney Marshes, Bow, and Limehouse, 2,201 carcases, and from January 1st to October 6th, 1903, between Tottenham and Hertford 70 carcases.

In every case where any unsatisfactory liquid is found discharging from any sewage works, farm, or other place, samples are taken in triplicate as directed by Section 31 of the Act of 1900, and sent to the Board's chemist for analysis. If the result is unsatisfactory, proceedings are threatened or taken.

To remove any doubts as to the validity of some notices served on the local authorities many years ago under the 1868 Act, fresh notices of three months have been given under the Act of 1900 on nearly all the authorities in the watershed.

Several prosecutions of local authorities have taken place within the last few months with not altogether satisfactory results. In some cases adjournments have been granted several times, and in others the summonses have been allowed to be withdrawn on the authority satisfying the justices that additional works were being carried out to remove the pollution, and paying the costs of the Conservancy.

Rivers Pollution Act, 1876.

By Section 9 it is enacted as follows:—

> "The Conservancy Board constituted under the Lee Conservancy Act, 1868, shall within the area of their jurisdiction have, to the exclusion of any other authority, the powers for enforcing the provisions of this Act which sanitary authorities have under this Act.
>
> "The said Conservancy Board may also enforce the provisions of the Lee Conservancy Act, 1868, under the head or division 'Protection of Water' by application to the County Court having jurisdiction in the place in which any offence is committed against those provisions, and such court may by summary order require any person to abstain from the commission of any such offence, and the provisions of this Act with respect to summary orders of County Courts and appeal therefrom shall apply accordingly."

The Conservancy Board, some years ago, took proceedings against a local authority under this Act, and obtained a conviction before its County Court judge.

The objection to this process is, that after the expiration of the notice from the Conservancy under their own Act, they must give a two months' notice, under the 1876 Act, before commencing proceedings (see Section 13); thus additional delay is occasioned.

Lee Valley Sewer Scheme.

This subject was first introduced by the late Sir Joseph Bazalgette in a report which he made in 1867, recommending the construction of a main sewer from Hertford, down the Lee Valley, ending at Barking, with two branch lines called the "Barnet branch" and the "Hornsey branch," to take the whole of the sewage of the Lee Valley right away, and to be treated at Barking. That scheme was revived in 1882 by Sir Joseph Bazalgette, C.B., Major Lamarock Flower, and Messrs. Law and Chatterton, with the addition of a branch sewer to take the sewage of the River Stort Valley, and one called the "Waltham Abbey and Epping branch." The latter report and plan was circulated amongst the various local authorities, but nothing came of it.

In 1897 the late Mr. Edward Rider Cook, the then chairman of the Lee Conservancy Board, feeling that the time had arrived when something further should be done to revive the foregoing scheme, brought the matter prominently before the Board. It was referred to the Parliamentary Committee, who made the following report:—

Report of Parliamentary Committee.

"28th January, 1898.—At a meeting of the Parliamentary Committee held at the Head Office on Friday, the 28th day of January, 1898.

Present:

"Edward Rider Cook, Esqre. (in the chair).
"Andrew Johnston, Esqre.
"William Barnard, Esqre.
"Arthur R. Prideaux, Esqre.

"The minutes of the last committee meeting were read and confirmed.

"The following reference from the Board of the 26th November last was considered, namely:

> "'That it be referred to the Parliamentary Committee to consider as to conferring with the Local Government Board as to the necessity of a scheme being put forward for carrying the sewage of the lower part of the Lee Valley right away to Barking.'
>
> "It may be interesting to the Board to know that in 1866 this same question was under the consideration of several of the local authorities. A committee was formed representing the parishes of Tottenham, Hornsey, and East Barnet, and the visiting justice of the Colney Hatch Lunatic Asylum, upon the then drainage of those districts, and they called in the late Sir Joseph Bazalgette, engineer of the Metropolitan Board of Works, to assist them.
>
> "In 1867 he presented a report and plan dealing with the question on a more extended scale. His scheme was to have a main sewer from Hertford down to Barking, taking in all the towns en route, including West Ham, East Ham, and Little Ilford, with a branch sewer up to East Barnet.
>
> "This movement was suggested by the report of the Royal Commission on Pollution of Rivers (River Lee), 1866, when none of the towns in the valley, except Hertford and Tottenham, had any proper drainage systems. The main sewer was to be made to a large extent of concrete in lieu of brickwork—to be 4ft. 6in. in diameter to 3ft. by 2ft., its general fall being 5ft. 6in. per mile; surface waters to be excluded.
>
> "The approximate estimate was £500,000, to be paid off in 40 years. Rate 10d. in the pound. The report does not say if that included any items for compensation, &c. The idea was to form a Commission or Board on which all the districts were to be fairly represented, including the two water companies and the Lee trustees, and the report suggests that there was 'no doubt these three bodies would between them willingly contribute half the estimated outlay.'
>
> "A public meeting was held at the Clerkenwell Sessions House, when the following places and bodies were represented:—Tottenham, Edmonton, Hornsey, Walthamstow, Leyton, West Ham, East

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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Barnet, Colney Hatch Asylum and East London Waterworks Company.

"The Government was interviewed to see if they had any intention to introduce a general scheme for draining the Lee Valley, and if not, how far their aid might be calculated on in promoting a scheme of the character contemplated. The Home Secretary answered that 'the towns must themselves take the initiative, and that the Government were not prepared by any general measure to relieve the various parishes from their obligations in respect of the provision of adequate sewerage works.' The report was printed and circulated, but nothing further came of the scheme. The Lee Conservancy Act, 1868,' passed, and, to comply with its provisions, the various towns and villages set about carrying out separate and distinct sewerage schemes—each for its own district—and large sums of money were then, and have since, been expended on them.

"In 1882 the Report of 1867 was extended and developed in a scheme and plan prepared by Sir Joseph Bazalgette, Major L. Flower, the sanitary engineer of the Lee Conservancy, and Messrs. Law and Chatterton.

"The plan suggested an additional sewer going up the Stort Valley as far as Sawbridgeworth.

"The total estimate, including compensations, land, etc., was a rate of sevenpence in the pound, and, if West Ham was included, sixpence in the pound, for fifty years. The Report goes on to say on pages 9 and 10:

> "'At present we have each separate place with the necessity and responsibility of disposing of its own sewage with its chemical works and pumping station or its sewage land, as the case may be, all constant sources of anxiety and expense and liable at any moment to become nuisances without constant and unremitting vigilance and care. As populations grow and the lands surrounding these works become requisite for building purposes the necessity and the impossibility of their enlargement and extension simultaneously become evident. In endeavouring to deal with sewage within a residential neighbourhood the difficulties are ever increasing, and it is impossible to conceive any plan which shall be final and complete.
>
> "'On the other hand by the construction of an intercepting sewer to convey the sewage away from the district all these difficulties are surmounted at once and for ever. We claim for the proposed remedy—finality and completeness—the Local Sanitary Authorities being relieved from all future trouble, anxiety and expense save only their annual rate which will diminish as the population of their district increases.
>
> "'In order to carry into effect the scheme above described it would only be necessary to form a joint Board composed of representatives from the several places whose sewage has to be dealt with, to whom would be committed the construction and subsequent management of the outfall sewer and works, but this Board would in no way interfere with the internal drainage of these several places, which would remain as at present in the hands of the local sanitary authorities.'

"This really sums up the whole situation, and even though the Conservancy may not be successful in getting the Government to take up the matter, it will put on record the fact that the Board have not been indifferent to the necessity of some such scheme being carried out, in the interests of all concerned. Of course it will be expected that some of the local authorities, who have expended large sums on their sewerage systems, will naturally raise strong objections to any additional outlay in that direction, although in years to come it may prove to be a great saving. Take Hertford—something must be done here sooner or later. Ware.—The lease of their sewage farm is just about to expire. Bishop Stortford is in difficulties and is anticipating an extra outlay of thousands of pounds. Cheshunt sewage farm is saturated, and the effluent largely pollutes the intercepting drain, and the same may be said of Enfield as well as many other places in the Valley, not forgetting the bad position and condition of Walthamstow at the lower end. Tottenham and Hornsey are now out of it, as they are joined to the metropolitan system, and it is anticipated that West Ham will be the same within a year or two.

"The only complete remedy for all this is, as your sanitary engineer has been continuously pointing out for many years, to take all the sewage right out of the Valley.

"Your committee therefore beg to recommend as a first step—

"That a memorial to the Local Government Board on the subject be prepared and that this report be referred back to the committee for that purpose."

WEST HAM CORPORATION BILL.

"On receiving a report from the Clerk as to his interview with Mr. F. E. Hilleary, the Clerk of the Corporation, with reference to their proposal to obtain power to appoint a conservator, also as to the vacancy which has now occurred for a representative of local authorities by the resignation of Mr. Beck.

"Your Committee recommend—

"That the matter be further adjourned, and if the Clauses Nos. 48, 49 and 50 affecting this question be not withdrawn by the time allowed for petitioning that a petition be lodged accordingly.

"The further consideration of Clauses Nos. 51, 52 and 53 as to dredging and cleansing the back rivers about Stratford was adjourned.

"Parliamentary Agent.—Your Committee recommend—

"That Mr. John Kennedy, Parliamentary Agent of Abingdon Street, S.W., be engaged as the Parliamentary Agent for the Board for this Session.

(Signed) "EDWD. RIDER COOK,
"Chairman."

Upon that the following circular was issued to the various local authorities:—

"Lee Conservancy,
"12, Finsbury Circus.
"London, E.C.

"Gentlemen, "10th March, 1898.

"I am directed by the Lee Conservancy Board to communicate with you in the following circumstances, viz.:—

"One of the duties of the Board is, as you are aware, to preserve the purity of the water of the River Lee, and to prevent pollution, and, in order to do this, they have continually to watch the methods of dealing with sewage by the various local authorities of the towns and districts situate in the Lee Valley; also from time to time, as necessity arises, to press upon those authorities the importance of making improvements in or extensions of their systems or works.

"Having regard, however, to the comparative smallness of the river, to the continually increasing population upon its banks, and to the greater attention now fortunately given to sanitation, the Board has often discussed the question whether the time had not arrived, when an end should be put to sewage, either directly or indirectly, finding its way into the Lee. Also, whether by the construction of a main sewer from Hertford to Barking, with a branch from Bishop Stortford, and another from the Barnet district, a mode of sewage disposal should be found, which would not only avoid all possibility of the River Lee being polluted, but would save the heavy annual expenditure of the various authorities in the treatment of the sewage, either by chemical means or by sewage farms. There are no doubt many difficulties to be encountered before such a scheme can be carried out, but the Board feel that an effort to do so should be made, and, as every sanitary authority in the Lee and Stort Valleys is deeply interested, they propose, as the first step, to ask each of them to send a small deputation to a conference in London, when the whole matter can be fully considered, without any responsibility being incurred by anyone. When such conference meets, it is desirable that every possible information that can be obtained

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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should be available, and my Board will feel very much obliged to your Board, if they will kindly supply me with answers to the enclosed questions. The information sought is intended, as probably you will hardly need to be assured, only to enable my Board to arrive at some general ideas as to the cost of carrying out such a scheme which will be laid before the conference when it meets.

"My Board venture to solicit the hearty co-operation of your Board, in their efforts to grapple with a difficulty which sooner or later must be dealt with, and which they feel will be more difficult and more expensive the longer it is delayed.

"I am,
"Yours faithfully,
(Sigd) "Geo. Corble,
"Clerk.

"To the ....

"P.S.—The authorities of the following places have had a similar letter sent to them, viz.:—

"Hertford, Ware, Stanstead, Broxbourne, Hoddesdon, Bishop Stortford, Sawbridgeworth, Harlow, Roydon, Waltham Abbey, the Ordnance Factory, Enfield Lock, Enfield, Edmonton, East Barnet, Friern Barnet, High Barnet, Colney Hatch Asylum, Southgate, Chingford, Woodford, Buckhurst Hill, Leyton, Walthamstow, East Ham, and Ilford.

"Hornsey and Tottenham were taken into the metropolitan system some years since, and now West Ham is making arrangements with the London County Council with the same object."

Some of the authorities replied to the foregoing, giving the information required, but others took no notice of it.

The Conservancy afterwards addressed the following circular letter to the local authorities, viz.:—

"Lee Conservancy,
"12, Finsbury Circus, London, E.C.,
"12th August, 1898.

"Dear Sir,

"Lee Valley Sewer Scheme.

"I beg to inform you that at a meeting held at this office on Thursday, the 4th instant, to consider the question of a Lee Valley Sewer Scheme, representatives from the following district councils, towns, etc., were present, namely:—

"Ware Urban, Ware District, Hoddesdon, Hertford Corporation, Bishop Stortford, Cheshunt, Waltham Abbey, Enfield, Edmonton, Enfield Lock Royal Small Arms Factory, Walthamstow, Southgate, East Barnet, Friern Barnet, Chingford, Ilford, West Ham.

and the following resolutions were passed, namely:—

"1. 'That the representatives of the different local authorities, including the War Department, in the Lee Valley, here present, are of opinion that it is desirable that some scheme for the proper disposal of the sewage in the Lee Valley should be placed before the local authorities for consideration and approval.'

"2. 'That a committee, consisting of one representative from each local authority, the War Department, and the Lee Conservancy Board, with the chairman as *ex officio*, be appointed to consider a scheme for the proper disposal of the sewage in the Lee Valley, to lay before the local authorities for consideration.'

"Both resolutions were carried *nem. con.*, those who did not wish to vote being Ware Rural, Ware District, and Edmonton.

"In accordance with the second resolution, the Lee Conservancy Board will be obliged if your council will be good enough to appoint a representative (and send me his name) to attend a meeting which will be held here on Thursday, the 6th day of October, at 2.30 p.m., further to discuss the matter.

"I am, Dear Sir,
"Yours faithfully,
(Signed) "Geo. Corble, Clerk."

Extracts from Minutes of the Lee Conservancy Board.
Lee Valley Sewer.

4th February, 1898.

Report of Parliamentary Committee.—A report of the Parliamentary Committee entered on pages 66 to 73 of the Committee Minute Book, Vol. 4, as to the reference from the Board, 26th November, 1897.

"That it be referred to the Parliamentary Committee to consider as to conferring with the Local Government Board, as to the necessity of a scheme being put forward for carrying the sewage of the lower part of the Lee Valley right away to Barking, and

The Committee made the following recommendation, namely:—

"That a memorial to the Local Government Board on the subject be prepared, and that this report be referred back to the Committee for that purpose" and

It was resolved—

"'That the recommendation of the committee be approved, and that the various local authorities interested be approached without delay as to having a conference on the matter, and that the clerk do confer with the chairman as to this. On the suggestion of Sir Joseph Savory, Bart.,

It was resolved—

"'That it be ascertained whether a room could be obtained at the Guildhall for the conference, and in the meantime certain information be obtained from the local authorities, as requested in the sanitary engineer's report.'"

14th October, 1898.

Protection of Water.

Lee Valley Sewer. Meeting of Sanitary Authorities.

The Chairman reported that the following resolutions were passed at a meeting of representatives of the sanitary authorities in the Lee Valley, held on the 6th instant, viz.:—

"That the question of the proper disposal of the sewage of the Lee Valley be now further considered.

"That the offer of Major L. Flower and Mr. G. Chatterton, C.E., to place the details of their scheme before a conference of the various sanitary authorities be accepted, supplemented, if possible, by some estimate of the practicability of combining the Districts of the Rivers Lee and Roding in such scheme, and the preliminary cost not to exceed 100 guineas for out-of-pocket expenses.

"That a copy of the foregoing resolutions be forwarded to the 21 sanitary authorities interested, and that each be asked to contribute a sum of five guineas towards the preliminary expenses.

"That this meeting be adjourned to Wednesday, the 26th inst., at 2.45 p.m., to further consider the question."

The following were present at the meeting:—

Sanitary Authorities.	Represented by.
Ware Urban - - -	Mr. T. Burgess.
Hoddesdon - - -	Mr. T. M. Gardner.
Bishops Stortford -	Mr. Jas. L. Wigan.
Waltham Holy Cross -	Mr. W. Beck.
Cheshunt - - - -	Mr. T. A. Hewitt.
Enfield - - - -	Mr. J. J. Wilson.
Edmonton - - -	Mr. J. Williams & Mr. E. E. Eachus, Engineer.
East Barnet - - -	Mr. C. Gray.
Southgate - - -	Mr. E. E. Corke.
Chingford - - - -	Mr. Ben. Crook.
Buckhurst Hill - - -	Mr. E. H. Baily.
Walthamstow - - -	Mr. John Anderson.
East Ham - - - -	Mr. Murty.
Royal Small Arms Factory, Enfield Lock - -	Major Stokes-Roberts, R.E.
Essex County Council -	Mr. W. B. Whittingham.

There were also present: Messrs. R. B. Croft (Chairman), Andrew Johnston, A. R. Prideaux, John Abbott, and Wm. Beck (also representative of Waltham Holy Cross).

It was resolved—

> "That Mr. Andrew Johnston be appointed as the representative of the Conservancy, to attend with the Chairman the meetings of the authorities."

It was resolved—

> "That the County Councils of Herts, Middlesex, and Essex be asked to each send a representative to the meetings of the authorities."

Sanitary Engineer's Report.

The report of the sanitary engineer on the foregoing matter, and as to the preliminary expenses of preparing and submitting the scheme to the next meeting of the authorities, was read.

28th October, 1898.

Lee Valley Sewer Scheme.

The Chairman reported that at the meeting of the representatives of the various sanitary authorities to consider the Lee and Roding Valleys sewer scheme, when there were present 17 representatives of various urban district councils, Mr. George Chatterton, C.E., Mr. Maurice Anderson, Parliamentary Agent, Conservators, Mr. Richard B. Croft in the chair; Mr. Andrew Johnston, Mr. J. Abbott, Mr. A. Prideaux, Mr. T. Gardner, and Mr. Wm. Beck and Mr. Idris.

After considerable discussion (see the shorthand notes of the proceedings)

It was resolved—

> "That a copy of the report made by Major Flower and Mr. Geo. Chatterton on the scheme, with the Ordnance plan showing the lines of the proposed sewers, be forwarded to each sanitary authority interested, on their contributing a sum to cover the cost of the same, not to exceed five guineas in each case, this to be in addition to the five guineas previously required for 'preliminary expenses.'"

No guarantee being forthcoming for the amount necessary to cover the expenses of promoting the Bill in Parliament during the next Session, it was understood that the matter must remain in abeyance for a time.

After a vote of thanks to the Chairman for presiding, the meeting was adjourned *sine die*.

Report of Sanitary Engineer, 28th October, 1898.

Lee Valley Sewer Scheme.

Conference on Main Outfall Sewer, Lee and Roding Valleys.

"I wish to record the fact that a meeting of delegates from several authorities was held yesterday, when, as promised, I presented full plans of the proposed scheme and estimates which had been prepared in detail, a large cartoon of the districts affected, showing the line of sewer and branches, and also a Bill and notices for application to Parliament. I also produced estimate of cost of depositing the Bill, framed on the out-of-pocket expenses cost only, which amounted to £2,500, or about £100 each for every authority affected. This would carry the matter up to the second reading. The chief part of the expense would be for referencing, serving notices on owners and occupiers, and printing, and it is necessary, if this matter is to go on, that £2,500 be guaranteed, £1,000 to be deposited at once, so as to be in a position to instruct the referencer to proceed on Monday with the work; the plans are in readiness, and only require to be amended up to date in detail.

"Of course the local authorities have no power, without consent, to guarantee this money, and meetings could not be held in time, and if we let this special opportunity pass, it will, at least, lead to another year's delay, and make the work all the more difficult.

"The money would only be advanced and returnable out of the first moneys received after the Act is obtained.

"I have reason to know that the scheme will receive every support from those in authority, and I do trust that such an opportunity, which may never come again, will not be permitted to slip.

"I had the pleasure to introduce my colleague, Mr. George Chatterton, a son-in-law of Sir Joseph Bazalgette, who superintended the West Kent main sewer, has just completed that of the Rhondda Valley, and is carrying out the main drainage of Dublin; and also Mr. Maurice Anderson, of Lewin Gregory and Anderson, 6, The Sanctuary, Westminster, Parliamentary Agent, who has drawn the Bill and notices.

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr R. B. Croft, Mr. E. B. Barnard, and Mr. H Nield.

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"Our joint experiences at only out-of-pocket expenses is clearly to the advantage of the scheme.

"As a matter of public health it is urgent. Walthamstow is getting into a fearful state, and is bound to act somehow.

"It has been suggested that we only take the sewage below the intakes commencing at Enfield.

"Again, as Hertford intends to oppose, and Ware seems indifferent, that we carry the main sewer up to Ware only, I reserve my opinion on these points.

"The meeting adjourned *sine die* for the preparation of a printed report and maps for the consideration of the several authorities, on which the staff is now engaged, and this will, I trust, shortly be ready; but time and opportunity cannot be thrown away, and I venture to hope that someone interested will be found to guarantee the fund till the authorities subscribe.

"Following the foregoing remarks I annex letters from Hackney Vestry, with analysis, which speak for themselves.

"I also find from Mr. Angell that on the 19th instant much crude sewage was escaping from the mouth of Leyton Culvert into 'Henniker's Ditch,' that communicates with the Channelsea: this is from the 'storm overflow' of Leyton sewers, which would be abolished by the joint scheme.

"An idea was started that a joint district might be formed by Local Government Board Provisional Order under Section 279 of the Public Health Act, 1875, but the population of the districts being over 25,000 each are beyond the limits, and it is only by a private Bill that we can get rid of the nuisance of sewage in the lower districts of the Lee, in which I fear we shall have a pestilence before long if matters remain unremedied.

11th November 1898.

Lee Valley Sewer Scheme.

Local Government Board.—A letter from the Local Government Board, dated the 2nd instant, 121,985 K. 1898, asking for information as to the result of the recent conferences of the sanitary authorities as to the proposed Lee Valley Sewer Scheme, also asking for a general map of the districts within the Lee Valley, was read, and

It was resolved—

> "That the reply of the Clerk of the 7th instant be approved."

5th January, 1900.

Lee and Roding Valleys.

Main Outfall Sewer Scheme.—The following letter from the Local Government Board as to the "Lee and Rodings Valleys Main Outfall Sewer" Scheme was read, namely:—

"160301 K 1899.
"Local Government Board,
"Whitehall, S.W.,
"1st January, 1900.

"Sir,—I am directed by the Local Government Board to advert to your letter of the 29th of November last, and to state that they have not promised an inquiry in regard to the scheme for the drainage of the districts in the Lee Valley to which you refer. They instructed one of their Inspectors to visit the various districts which would have been interested, but they found that the general feeling was very much against such a scheme, and they see no present prospect of its being proceeded with.

"I am, Sir,
"Your obedient servant,
(Signed) "Noel T. Kershaw,
"Assistant Secretary.

"The Clerk of the Lee Conservancy,
"12, Finsbury Circus, E.C."

16th March, 1900.

Lee and Roding Valleys Main Drainage Scheme.

Mr. Idris.

Mr. Idris called attention to the question of the Lee and Roding Valleys Main Outfall Sewer, to which the Board had directed the attention of the various local authorities in the watersheds, and respecting which

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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meetings thereon were held at the head office of the Board; and, after some discussion, Mr. Idris gave the following notice of motion for the next meeting, namely:—

> "That in reference to the question of the proposed 'Lee and Roding Valleys Outfall Sewer,' having for its object the taking away of the sewage of the districts in the lower part of the Lee entirely out of the watershed, and respecting which three conferences were held in 1898 between the Lee Conservancy Board and the various local authorities interested, a representation be again made to the Local Government Board, requesting them to institute a further inquiry into the matter, in view of the increasing urgency of some such scheme being carried out in the interests of the public health."

27th April, 1900.

Lee and Roding Valleys Sewer.

Motion by Mr. Idris.—Mr. Idris moved, according to notice given, and Mr. Ivey seconded, and

It was resolved—

> "That in reference to the question of the proposed Lee and Roding Valleys Main Outfall Sewer, having for its object the taking away of the sewage of the districts in the lower part of the Lee entirely out of the watershed, and respecting which three conferences were held in 1893 between the Lee Conservancy Board and the various local authorities interested, a representation be again made to the Local Government Board, requesting them to institute a further inquiry into the matter, in view of the increasing urgency of some such scheme being carried out in the interests of the public health."

22nd June, 1900.

Lee and Roding Valleys Sewer Scheme.

Local Government Board.—The following extract of a letter from the Local Government Board was read, namely:—

> "Local Government Board,
> "25th May, 1900.
>
> "The Board hoped they would be able to induce the above-mentioned authorities (Urban District Councils of Walthamstow, Leyton, and East Ham) to take joint action in the matter, but, as will be seen from the enclosed copies of letters which have been received from the three Councils, their efforts in this direction have been unsuccessful.
>
> "I am to add that the Board will now resume as a matter of urgency their consideration of the application of the Urban District Council of Walthamstow for sanction to borrow money for the execution of an independent scheme of sewerage and sewage disposal for the district to which reference is made in the letter from that Council, dated the 2nd instant.
>
> (Signed) "JOHN LITHIBY,
> "Assistant Secretary."

"Leyton Urban District Council,
"May 9th, 1900.

"The Council, having given the matter careful consideration, are unable to appreciate the advantages to be derived by Leyton in joining in such a scheme as that suggested, having regard to the enormously increased expenditure which would be entailed thereby, and to the already heavy rates necessarily imposed upon the ratepayers.

(Signed) "R. VINCENT."

"East Ham Urban District Council,
"30th April, 1900.

"My Council do not consider that they have anything to do with the matter until some scheme is agreed upon between Leyton and Walthamstow, and that scheme has received the approval of the Local Government Board.

"When this has been done they will be prepared, as stated by them in the interview, to give it their very best consideration, and endeavour to carry out the wishes of the Local Government Board so far as they are able to do so without detriment to their own district.

(Signed) "C. E. WILSON."

"Walthamstow Urban District Council,
"May 2nd, 1900.

"The Council are still desirous of proceeding with the septic tank treatment, a scheme for the establishment of which has been before the Board since September last.

(Signed) "E. J. COWEN."

It was resolved—

> "That a letter in the terms suggested by the Sanitary Engineer be sent in reply."

21st December, 1900.—The Engineer of the Conservancy reported on certain letters he had received from the various local authorities, and reported the progress of the negotiations as to the scheme.

15th March, 1901.—The Engineer reported satisfactory progress of the negotiations with local authorities.

3rd May, 1901.—The Engineer again reported, and as to action of Local Government Board.

28th June, 1901.

Lower Lee Valley Sewer Scheme.

Reported meeting of authorities at the Board's office on the 10th instant, when the following resolutions were passed, namely:—

> "1. That this conference resolves to represent to their several councils the advisability of forming a combined District Drainage Board for dealing with the Lower Lee Valley Improvement."
>
> "2. That this conference resolves that representation on the proposed Joint District Drainage Board be according to rateable value."

the meeting then adjourned until the 1st of July.

The report of the clerk thereon was read, with the application for the permission of the Board to allow Mr. Tween, the engineer, to prepare the preliminary plans, surveys, estimates, etc., as reported on page 139 ante and the resolution thereon passed.

In considering this question, the Board were strongly of opinion that the time had now arrived when, in the interests of preserving the lower portion of the Lee from pollution, that they should use every means in their power to urge forward the carrying out of this scheme.

Mr. Trenchard moved and Mr. Pryke seconded—

> "That the chairman be authorised to interview the chairman of the London County Council, and take such other steps as he may think advisable to ascertain definitely whether in the event of a Joint Drainage Board being properly formed the Council will be prepared to admit the sewage of the combined district into the metropolitan system.

12th July, 1901.

Lower Lee Valley Sewer Scheme.

The clerk reported that a meeting of the representatives of the various district councils interested in the scheme had been held at the Board's office on the 1st instant, when the following resolutions were passed, namely:—

> "1. That this conference, having heard that the Lee Conservancy are about approaching the London County Council to obtain a definite reply as to whether the Council will be prepared to take into their system the sewage of the drainage district proposed to be formed, and on what terms, that the Council be asked to give a reply at the earliest possible moment so that particulars may be communicated to the delegates of the various local authorities interested.
>
> "That this conference stands adjourned until the Lee Conservancy receive a reply from the London County Council, and then a communication will be made to each authority asking for the attendance of their representatives at another conference."

Mr. E. B. Barnard reported an informal interview he had had (by request of the chairman) with the chairman and deputy chairman of the London County Council, the clerk accompanying him, and after a discussion of the matter, the chairman of the London County Council intimated that if a combined drainage board would communicate direct with the Council they would consider as to whether they would be prepared to admit the sewage of the Lower Lee Valley into the metropolitan system.

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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The questions of the Board passing down the river daily the full quantity of water reserved to the navigation, under the Act of 1855, and as to passing water over Lee Bridge Weir were also discussed.

Reported that the next conference of the district councils would be held on the 15th instant, whereupon,

It was resolved—

> "That Mr. Gardner and Mr. Barnard do attend the same on behalf of the Board."

26th July, 1901.

Lower Lee Valley Scheme.

Mr. Barnard, with Mr. Gardner, reported the proceedings of the meeting of delegates of local authorities at the head office of the Board on the 15th instant; also a conference between the delegates and the Main Drainage Committee of the London County Council on the 25th instant,

Mr. Barnard moved—

> "That the Board take the necessary steps for preparing the necessary detail plans, surveys, and estimates of the scheme in order to assist and stimulate the local authorities to carry it into effect."

After considerable discussion,

It was resolved—

> "That the matter stand adjourned until a reply is received by the local authorities from the London County Council."

4th October, 1901.

Lower Lee Valley Sewer Scheme.

Mr. Barnard and Mr. Musgrave explained the position of affairs with the London County Council, who had promised a reply to the local authorities as soon as possible, whereupon,

It was resolved—

> "That the matter stand adjourned."

18th October, 1901.

Lower Lee Valley Main Sewer Scheme.

Attention was called to the remarks made by Mr. A. M. Torrance, chairman of the London County Council, in his annual address, delivered at the Council on the 8th instant, as follows:—

> "West Ham has been included in the main drainage system of the London County Council during the past year under powers conferred by Parliament, but the question as to the payments to be made by that district still remain unsettled. Steps are being taken to obtain contributions from districts draining into London without proper authority. The main drainage of London is so successful that many of the outlying districts beyond the county have been admitted to its advantage, and others are asking to be admitted. I confess I look with some degree of apprehension on this extension beyond London of benefits belonging to London. The outlying places are not too ready to accept London's guidance in matters where it is the predominant partner, such as water supply, and it is an open question as to whether it is right to allow these districts to participate in London's organisation just where it is agreeable, and to be rejected where it is deemed not to be so advantageous."

Mr. Bruce, one of the members representing the London County Council, stated that the foregoing remarks referred more particularly to the districts on the western side of London.

On the foregoing question Mr. Barnard moved, according to notice given, and Mr. Nield seconded:—

> "That, looking to the polluted condition of the River Lee and tributaries, and to the necessity for taking the sewage of the towns and districts affected right out of the valley—also to the largely increasing population of certain areas—the Lee Conservancy Board, in conformity with the powers given by Section 89 of the 'Lee Conservancy Act, 1868,' do assist the local authorities in carrying forward the 'Lower Lee Valley Sewer Scheme,' by at once preparing the necessary plans, surveys, estimates and Parliamentary notices at a cost of about £500, and that Mr. Tween, the engineer, do carry out this order and engage such assistance in the matter as he may require."

After considerable discussion, during which it was urged that some immediate action was necessary or twelve months would be lost before any Parliamentary action could be taken,

Mr. Pryke moved, as an amendment, and

Mr. Gardner seconded,

> "That, looking to the polluted condition of the lower portion of the River Lee and tributaries, and to the necessity for taking the sewage of the towns and districts affected right out of the valley—also to the largely increasing population of certain areas—the Lee Conservancy Board, in conformity with the powers given by Section 89 of the Lee Conservancy Act, 1868, do assist the local authorities in carrying forward the 'Lower Lee Valley Sewer Scheme,' by preparing the necessary plans, surveys, and estimates at a cost of about £500, and that the local authorities interested in the matter be consulted from time to time.
>
> "Also that Mr. Tween, the engineer, do carry out this order, engaging such assistance on the work as he may require, and reporting to the Board thereon within three months from this time."

The amendment being put, the following voted for it, namely:—

Messrs. Pryke, Gardner, Smith, Bruce, and Musgrave.

The following voted against it, namely:—

The Chairman, Messrs. Barnard, Belsham, Nield, Oakley, and Lowndes.

The amendment was therefore declared to be lost.

The original motion being then put,

It was resolved—

> "That, looking to the polluted condition of the lower portion of the River Lee and tributaries, and to the necessity for taking the sewage of the towns and districts affected right out of the valley—also to the largely increasing population of certain areas—the Lee Conservancy Board, in conformity with the powers given by Section 89 of the 'Lee Conservancy Act, 1868,' do assist the local authorities in carrying forward the 'Lower Lee Valley Sewer Scheme' by at once preparing the necessary plans, surveys, estimates, and Parliamentary notices, at a cost of about £500, and that Mr. Tween, the engineer, do carry out this order, and engage such assistance in the matter as he may require."

A letter from Mr. John Kennedy, dated the 16th October, 1901, on the foregoing question was read.

It was resolved—

> "That with regard to giving any Parliamentary notices, Mr. John Kennedy be the Parliamentary Agent to act on behalf of this Board."

1st November, 1901.

Lower Lee Valley Sewer Scheme.

The report of the Parliamentary Committee, dated the 26th ult, page 181 of the Committee Minute Book, Vol. 4, was read, with the recommendation as follows:—

> "It appearing that the various local authorities were awaiting a reply from the London County Council as to whether the Council would take into the Metropolitan system and deal with the sewage of the districts of the Lee from Waltham Abbey downwards, and that on receipt of that answer some time would necessarily elapse before the authorities could consider and decide as to their line of action."

It was resolved—

> "That it be recommended to the Board that no steps be taken with regard to the publication of a Parliamentary notice for the ensuing session, but that the engineer do proceed with the survey, levels, referencing, etc., for the scheme as ordered."

Whereupon,

It was resolved—

> "That the report of the Parliamentary Committee be received and adopted."

24th January, 1902.

Tottenham Sewage Works.

The sewage of this district is connected with the Metropolitan system, but at times of storm there is an overflow of sewage into the River Lee (see reports of water bailiffs).

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween Mr. W. C. Young, Mr. R. E. Croft, Mr. E. B Barnard, and Mr. H. Nield.

20 Oct. 1903.

It was resolved—

"That a letter be addressed to the Tottenham and Wood Green Joint Drainage Committee upon the subject."

Lee Valley Drainage Scheme.

The engineer reported progress of the work of taking levels, sections, etc., of district from Waltham Abbey to London.

Lee Valley Drainage Scheme. Suggested Extension.

Referring to the minutes of the 18th of October and 1st November, 1901, by which the Board resolved to prepare plans, sections, etc., for taking the sewage of the towns and places from Waltham Abbey downwards right out of the Lee Valley.

Mr. Barnard moved, and Mr. Trenchard seconded, and

It was resolved—

"That a separate survey be made and plans and sections prepared of the district comprising Bishop Stortford, Sawbridgeworth, and Harlow on the River Stort, with the view of intercepting the sewage of those places, and this without prejudice to the scheme for carrying the sewage of the towns and places below Waltham Abbey out of the valley, but that provision should be made for the connection of the two schemes, should it be found desirable to do so in the future.

"Also, that the engineer be and he is hereby authorised and empowered to employ and engage such assistance as he may require to carry out the foregoing resolution."

Bishop Stortford Sewage.

A letter from the Bishop Stortford Urban District Council by Mr. T. Swatheridge, the Clerk, dated the 22nd instant, referring to the difficulties they have to contend with as regards the disposal of their sewage (the same being the case with the towns of Sawbridgeworth and Harlow below them), and asking the Conservancy to comprise in their survey for a Lee Valley drainage scheme the upper districts, as suggested in the foregoing notice of motion, was read, and referred to the engineer.

21st February, 1902.

Lee Valley Drainage Scheme.

Resolved—

"That a letter be written to the London County Council asking them on what terms they would take the sewage of the Lee Valley into their system, as they were hardly likely to give a reply to anyone but a properly constituted authority, and, further, that the Council be informed officially that as far as the Board is concerned, no person except their own officers has any authority from them to enter into negotiations or make any arrangements or proposals with regard to the scheme."

The engineer reported that Messrs. Pollard and Tingle, Engineers, of 31, Old Queen Street, S.W., who acted for the Lee Valley Drainage Commission, had been engaged by him to assist in making the surveys, taking levels, etc., and

It was resolved—

"That this arrangement be approved."

West Ham and the Lee Valley Sewer Scheme.

It was resolved—

"That the West Ham Corporation be asked to approve of a line of sewer pipes to go through their district, in accordance with the plan now submitted."

Channelsea River. Lee Valley Sewer Scheme. Leyton and Walthamstow.

A letter from the Local Government Board, dated the 22nd ultimo, adverting to the Conservators' letter of the 3rd August last as to West Ham, and asking for information as to whether any decision had been come to, as to forming a combined drainage district for the lower part of the Lee Valley, with a view to an arrangement being made for the discharge of the sewage into the Metropolitan system of sewers. Also as to the present position of the action taken in the High Court by the Leyton Urban District Council against the Walthamstow Urban District Council, was read.

A letter from the Leyton Urban District Council, dated the 24th ultimo, stating that the injunction was still in force, but the operation was suspended to enable works for which sanction was obtained to be completed, was also read.

The Clerk reported that he had, on the 29th ultimo, replied to the Local Government Board on all these points, whereupon

It was resolved—

"That the answer be approved."

18th April, 1902.

Lee Valley Water Scheme.

A letter from the London County Council, by Mr. Gomme, the Clerk, dated the 11th instant, was read as follows:—

"I have to inform you that the Council has not yet arrived at any decision with regard to the drainage of the Lower Lee Valley, and, having regard to the magnitude of the questions involved, I am afraid that I shall not be able to send you a definite reply for a few weeks."

Mr. Smith, as representing the Council, explained the reason of the delay, the chief difficulty of the Council against giving a definite reply being the want of information as to the amount of storm water to be dealt with at the outfall.

16th May, 1902.

Lee Valley Sewer Scheme.

The engineer presented the report, a copy of which is hereunto annexed, plans and estimates of the scheme, as ordered by minute of the 18th of October, 1901, page 245, *ante*.

Also the report of Sir Alex. Binnie on the same. Whereupon

It was resolved—

"That a copy of the reports and plans be sent to the following, namely:—

"Local Government Board.
"London County Council.
"West Ham Corporation.
"East London Water Works Company.
"New River Company.
"Leyton Urban District Council.
"Walthamstow do.
"Chingford do.
"Edmonton do.
"Southgate do.
"Enfield do.
"Cheshunt do.
"Waltham Abbey do.
"Superintendent of the Royal Small Arms Factory.
"Superintendent of the Royal Gunpowder Factory.

"with letter expressing the Board's approval of Sir Alexander Binnie's report."

As to the manner in which the Board will approach the local authorities interested, with a view to a conference on the subject, and also

As to taking legal advise as to any, and if what, steps the Board can take in the carrying out of the scheme.

It was resolved—

"That these questions stand adjourned."

30th May, 1902.

Lower Lee Valley Sewer Scheme.

Reported that copies of the reports and plans had been sent to the local authorities and others as ordered at the last meeting also to each Conservator.

Mr. Smith, one of the representatives of the London Council, reported that the Council were taking a much more favourable view of the question, and had referred it to the Local Government Committee and the General Purposes Committee.

Letters from the Urban District Councils of Enfield, Walthamstow, and Cheshunt, asking to be supplied with more copies of the reports, having been considered,

It was resolved—

"That they be supplied with further copies at the net cost of 10s. each copy."

On the motion of the chairman,

It was resolved—

"That a committee consisting of Mr. Barnard, Mr. Bellsham, Mr. White, Mr. Nield, and both of the London County Council representatives be appointed to confer with the local authorities concerned with the Lower Lee Valley, etc., scheme."

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

20 Oct. 1903.

It was resolved—

> "That the advice of Mr. Kennedy, W.S., the Parliamentary Agent, be taken as to any and if what steps the Board can take to assist in the carrying out of the scheme."

It was resolved—

> "That in forwarding the copy of the report to the Local Government Board, a special letter be written upon the matter, and that they be asked to receive a deputation from this Board."

11th July, 1902.

Lee Valley Drainage Scheme.

Reported that the committee on this question met at Westminster on the 30th ultimo and consulted with Mr. C. C. Hutchinson, Counsel, and Mr. John Kennedy, Parliamentary Agent, on the legal position of the Board in the matter.

Reported that no replies had as yet been received from the local authorities fixing appointments with the Board's committee to discuss the scheme.

The engineer also reported an interview he had with Sir Alexander Binnie, as to the scheme.

The following letters were read, viz., 80,009 K. Local Government Board:—

"Whitehall, S.W.
"21st June, 1902.

"Sir,—I am directed by the Local Government Board to advert to your letter of the 11th inst., with reference to the question of the disposal of the sewage of the districts situated in the lower part of the valley of the River Lee.

"I am to state that the President has given the matter very careful consideration, and that the Board fully recognise the advantages which might be expected to accrue from such a combination of authorities as is suggested, if it was made with the assent of these authorities. Unless, however, the Lee Conservancy Board are in a position to show that the majority of the local authorities which it is proposed should combine for the execution of such combination, the President thinks that it would be useless to trouble the deputation from the Conservancy Board to attend at this office.

"I am, Sir,
"Your obedient servant,
(Signed) "JOHN LITHIBY,
"Assistant Secretary.

"The Clerk to the
"Lee Conservancy Board.

"63773. M. "Local Government Board,
"Whitehall, S.W.
"8th July, 1902.

"Sir,—I am directed by the Local Government Board to advert to your letter of the 9th May last, and to inquire what progress has now been made with regard to the Lee Valley Sewerage Scheme, and whether a reply has yet been received from the London County Council with respect to that scheme.

"I am, Sir,
"Your obedient servant,
(Signed) "H. C. MONRO,
"Assistant Secretary.

"G. Corble, Esq.,
"Clerk to the Lee Conservancy Board."

And it was resolved—

> "That the Local Government Board be informed in reply to their letter of the 8th instant of the position of affairs between the Conservancy and the local authorities interested in the Lee Valley Sewer Scheme, and that no reply had as yet been received from the London County Council upon the matter."

Also that a letter be addressed to the London County Council, with a copy of the foregoing letter, dated the 8th instant, requesting the favour of a definite reply from them.

3rd October, 1902.

Lower Lee Valley Sewer.

The report of the Parliamentary Committee, dated the 26th ultimo, as entered on pages 232 to 241 of the Committee Minute Book, V. 4, having been read and considered at great length, the following recommendations of the Committee were agreed to, and

It was resolved—

> "That in the opinion of the Conservancy the best solution of the question of the purification of the River Lee and tributaries in the neighbourhoods of West Ham, Bow, Limehouse, and the East of London generally is the entire removal of the sewage effluents from the various towns and districts adjacent thereto from Waltham Abbey and downwards to and including Walthamstow and Leyton.
>
> "That the Board having had plans, surveys, and estimates prepared for a scheme to so deal with the sewage effluents, it is desirable that some practical steps should be taken to further the carrying out of the scheme.
>
> "That looking to the foregoing opinions of Counsel and the Parliamentary Agent, dated the 30th of June last, when they advised that the Board are not empowered to expend any of the Conservancy Funds on the promotion of such a Bill, it being a matter for the local authorities to combine for that purpose, an application be made to the Local Government Board for their advice as to the course the Conservancy should pursue in the matter, and whether, in the event of their promoting a Bill, *inter alia*, to effect the carrying out of the Lower Lee Valley Sewer Scheme, the Local Government Board would, under the special circumstances of the case, indemnify the Conservators against the costs in connection therewith."

It was also resolved—

> "That the Local Government Board be requested to receive a deputation from this Board on the question at an early date."

31st October, 1902.

Lee Valley Sewer.

Reported that the deputation of the Conservators waited on the Walthamstow Urban District Council of this place on Monday, the 27th instant. Also that a copy of the shorthand notes of the conference would be sent to each member of the Board in due course.

Local Government Board.—The following letter was read, namely:—

"127878 K. 1902.

"Local Government Board,
"Whitehall, S.W.,
"20th October, 1902.

"Sir,—I am directed by the President of the Local Government Board to advert to your letter of the 6th instant with reference to the question of the disposal of the sewage of the districts situated in the lower part of the valley of the River Lee, and I am to state that he is advised that it is for the local authorities concerned, and not for the Lee Conservancy Board, to determine in what manner the needs of their districts as regards sewerage and sewage disposal are to be met. The functions of the Conservancy Board in the matter would seem to be mainly those referred to in Section 89 of the Lee Conservancy Act, 1868, and, this being so, the Board could not in any way make themselves parties to the promotion of such a Bill as is contemplated by the Conservancy Board.

"Under these circumstances the President is unable to see that any advantage would be likely to result from the attendance of a deputation as suggested.

"I am, Sir,
"Your obedient servant,
(Signed) "NOEL T. KERSHAW,
"Assistant Secretary.

"The Clerk of the Lee Conservancy Board."

Stepney Borough.—Mr. J. Bellsham reported that at a meeting of the Poplar Borough Council, held on the 23rd inst., the following resolution was passed, namely:—

> "That this Council do petition the Local Government Board to assist the Lee Conservancy in passing the Lee Valley drainage scheme through Parliament, believing that it is necessary to construct such works to remove from the River Lee, as far as possible, the sewage and sewage effluents which now find their way, directly or indirectly, into the river, the water being supplied to London for drinking purposes."

NOTE.—During October, November, and December, the committee of the Conservancy Board waited on the following local authorities and fully discussed the

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

20 Oct 1903.

scheme. Copies of the shorthand notes of the proceedings are available.

Walthamstow.
Leyton.
Edmonton.
Enfield.
Southgate.

Cheshunt and Waltham Abbey declined to receive the Committee.

6th March, 1903.

Lower Lee Valley Main Sewer Scheme.

Mr. Alfred Smith, one of the representatives of the London County Council, reported certain proceedings of the Council which had taken place between the General Purposes Committee of the Main Drainage Committee of the Council with regard to this scheme generally, and the possibility of the Council co-operating with the Conservancy in some way to get the scheme carried through in the interests of the public health. That their engineer was in favour of the sewage being taken in the main drainage system of the Metropolitan sewer than having a separate outfall into the Thames, and, further, that as the matter would be further considered by the Main Drainage Committee, he thought it would very much assist any further matters if the deputation from the Board could attend that committee and more fully place their views before them.

Also that in any interview with the committee the full facts of the pollution from the storm water outlets at Old Ford should be brought forward and emphasised. Whereupon

It was resolved—

> "That Mr. Smith be thanked for his important communication and that the Main Drainage Committee of the Council be asked to receive a deputation from this Board, consisting of the Chairman, and Messrs. Barnard, Bellsham, Nield, White, and Trenchard."

1st May, 1903.

Lower Lee Valley Sewer Scheme. London County Council.

It was resolved—

> "That a letter be addressed to the London County Council, again asking, in reference to the minute of the 6th of March, 1903, whether they would receive a deputation from this Board on the subject."

12th June, 1903.

Lee Valley Sewer.

As to the deputation from this Board waiting on the London County Council on the 25th instant, it was resolved:—

> "That the same consist of the Chairman, Messrs. Barnard, Nield, Bellsham, White, Bruce, Trenchard, and Smith, and that a meeting be held at the head office on Tuesday next, the 16th instant, to arrange the course of procedure."

Also resolved:—

> "That power be, and it is hereby given, to the deputation to consult and engage such legal or engineering assistance as they may deem necessary in the matter."

Lee Valley Sewer Scheme.

Deputation to London County Council.

It was resolved:—

> "That it be pressed upon the Council that the only effectual way out of the difficulty as regards the pollution of the Lee is by the construction of a main intercepting sewer right out of the valleys, both of the Lee and Stort."

26th June, 1903.

Lee Valley Main Sewer Scheme.

A deputation from the Board, consisting of the Chairman, Messrs. Barnard, Nield, White, Bellsham, Trenchard, and Bruce, waited, by arrangement, on the Main Drainage Committee of the London County Council upon this matter. Mr. W. Goodman in the chair. The committee would not permit shorthand notes of the proceedings to be taken. After a few introductory remarks by the Chairman (Mr. Croft), Mr. Barnard explained, at length, the views of the Conservancy in reference to the scheme, and as to the necessity of a Bill being promoted by some sanitary authority, such as the London County Council, to divert the whole of the sewage right out of the district.

10th July, 1903.

The Conservancy addressed the following letter to the Royal Commission on Sewage Disposal:—

(Copy.)

"Lee Conservancy,
"12, Finsbury Circus,
"London, E.C.,
"10th July, 1903.

"Sir,—I am obliged for your letter of the 8th instant in reference to the request of the Lee Conservancy Board to give evidence before the Royal Commission on Sewage Disposal, as to the sewage in the Lee Valley generally.

"This question has, for the past thirty years, been one of very great difficulty and anxiety to the Conservators, as well as to the local authorities. Nearly every known system has been tried, but not one, I think I may safely say, has been a success in our watershed. The Conservancy have long since come to the conclusion that nothing but a combination of the various authorities interested to carry a main sewer down the valley and entirely divert the sewage right away will remedy the evil.

"To explain this, I cannot do better than to send with this a copy of an article which appeared in the 'East London Observer' newspaper on the 25th of October last, and which accurately sets forth the situation.

"As regards the sewage of the town of Hertford, the Conservancy have received a communication from the Local Government Board to the effect that it is hoped that the question may be referred to the Royal Commission, and if that is done, the Conservancy may then be able, if the Commission desire it, to give them some assistance by their officers and chemist on the question.

"There is little doubt that sooner or later the new Water Board established for London will have to take this matter into their serious consideration and bring all their forces to bear in the direction of solving the difficulty.

"I am, sir,
"Your obedient servant,
(Sgd.) "Geo. Corble, Clerk.

"The Secretary of the
"Royal Commission on Sewage Disposal,
"39, Victoria Street,
"Westminster, S.W."

31st July, 1903.

The Valley Water Scheme.

It was resolved:—

> "That it be referred to the Parliamentary Committee to consider the whole question of the Lee Valley sewer, and to report upon the best and most effective steps which might be taken to prevent the future pollution of the river."

11th September, 1903.

At a meeting of the Board, held this day, the following letters were read, namely, from the Royal Commission on Sewage Disposal and the Board of Trade:—

Royal Commission on Sewage.

"Royal Commission on Sewage Disposal.
"39, Victoria Street,
"Westminster, S.W.,
"4th August, 1903.

"Sir,—I am directed by the Royal Commission on Sewage Disposal to advert to your letters of the 1st and 10th instant, and to say that they will be pleased to receive the evidence offered by the Lee Conservancy in regard to sewage disposal in the Lee Valley.

"The Commission would wish the evidence to include information on the following points:—

"(A) The constitution of the Board.

"(B) The nature and scope of the powers of the Lee Conservancy in regard to pollution and the protection of water supplies.

"(C) The method of work adopted by the Conservancy for the detection and prevention of pollution.

"(D) The reasons why separate action on the part of the several local authorities has been unsuccessful; and

"(E) What alterations in the law the Conservancy consider desirable for the prevention of pollution and the protection of water supplies.

"Although the Commission have specified these points, they direct me to say that they do not desire to exclude evidence on any other matters in connection with the prevention of pollution and the protection of water supplies which the Conservancy think should be included.

"The Commission have fixed Tuesday, the 20th of October next, at 11 o'clock, for the attendance of the witness or witnesses who will represent the Conservancy, and I am to request that a statement of the evidence which is to be submitted may be furnished to the Commission, not later than the 6th of October.

"I am, Sir, your obedient Servant,
(Signed) "F. J. Willis, Secretary.

"G. Corble, Esq.,
"Clerk to the Lee Conservancy Board."

Hertford Sewage—

Board of Trade,
"(Fisheries and Harbour Depart.),
"7, Whitehall Gardens, London, S.W.,
"August 5th, 1903.

"Sir,

"Hertford Sewage.

"I am directed by the Board of Trade to advert to your letter of the 1st ultimo, with reference to the application made to them by the Lee Conservancy Board under the provisions of Section 9 of the New River Company's (Hertford's Sewage Diversion Act), 1854.

"I am to inform you that, in connection with the application by the Hertford Corporation for the sanction of the Local Government Board to a loan for the purpose of carrying out the proposed scheme for the disposal of the sewage of Hertford, that Department has suggested to the Board of Trade that it would be desirable that the Board should request the Royal Commission on Sewage Disposal to consider the proposed scheme, and to state whether, in their opinion, the system proposed can be regarded as 'the best now known practicable process' to which the sewage of Hertford ought to be subjected in compliance with the provisions of Section 8 of the New River Company's (Hertford Sewerage Diversion Act), 1854.

"In these circumstances, I am to inquire whether your letter of the 1st ultimo is intended to be regarded as a withdrawal of the application to this Department, or whether the Lee Conservancy Board merely desire a postponement of the consideration of the matter.

I am, Sir, your obedient Servant,
(Signed) "Walter J. Howell.

"The Clerk to the Lee Conservancy Board."

"Lee Conservancy,
"12, Finsbury Circus, E.C.,
"12th August, 1903.

"H. 10559.

"Dear Sir,

"Hertford Sewage.

"In answer to your letter of the 5th instant, I am directed by the Lee Conservancy Board to say that they do not wish to withdraw the application made by their letter of the 1st ultimo, but to have the question postponed for further consideration, possibly by the Royal Commission on Sewage Disposal.

"I also beg to inform you that the Commission have intimated to the Conservancy Board that they will be prepared to receive evidence from the Conservancy on the following points, namely:—

"(A) The constitution of the Board.

"(B) The nature and scope of the powers of the Lee Conservancy in regard to pollution and the protection of water supplies.

"(C) The method of work adopted by the Conservancy for the detection and prevention of pollution.

"(D) The reasons why separate action on the part of the several local authorities has been unsuccessful; and

"(E) What alteration in the law the Conservancy consider desirable for the prevention of pollution and the protection of water supplies.

"Although the Commission have specified these points, they direct me to say that they do not desire to exclude evidence on any other matters in connection with the prevention of pollution and the protection of water supplies which the Conservancy think should be included.

"I am, Sir, your obedient Servant,
(Signed) "Geo. Corble, Clerk.

"The Assistant Secretary,
"Fishery and Harbour Department,
"Board of Trade,
"7, Whitehall Gardens, S.W."

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

20 Oct. 1903.

9th October, 1903.

The engineer submitted a report and estimates and detailed plans of a proposed main intercepting sewer to take the sewage of the Lee Valley from Hertford and Bishops Stortford downwards to Leyton, and conveying the same to disposal works to the east of Barking Creek. And it was resolved—

"That a special meeting of the Board be held on Friday, the 16th day of October instant, at 12.30 o'clock in the afternoon."

9th October, 1903. The following resolutions have been received, viz.:—

"Enfield Urban District Council.

"Lee Valley Sewage Disposal.

"That the Surveyor be authorised to give evidence, if required, to the effect that the council were of opinion that a combined scheme for the treatment of the sewage from the whole of the districts in the Lee Valley would be the best that could be adopted, and, provided the cost was reasonable, the council would view such a scheme with favour."

Bishops Stortford, Sawbridgeworth, etc.

"That, subject to financial arrangements being satisfactorily adjusted, and to any additional expense beyond the requirements of the Public Health Act put on the local authorities in disposing of their sewage being borne by the water company or the Water Board, it is desirable that a main sewer should be constructed for the use of the united districts of Bishops Stortford, Thorley, Sawbridgeworth, and Harlow."

Walthamstow has also expressed their approval of the scheme.

16th October, 1903.—At a special meeting of the Lee Conservancy Board held this day, pursuant to a resolution passed on the 9th inst., to consider the report and estimates and detailed plans submitted by the engineer, of a proposed main intercepting sewer, to take the sewage of the Lee Valley from Hertford and Bishop's Stortford outwards to Leyton, and conveying the same to disposal works to the east of Barking Creek.

It was resolved—

"That the Board consider the scheme a reasonable and practicable one, and which, with the sanction of Parliament, would rid the Valley of the difficulties which have existed for many years past."

THE REASONS WHY SEPARATE ACTION ON THE PART OF THE SEVERAL LOCAL AUTHORITIES HAS BEEN UNSUCCESSFUL.

The foregoing history of the attempts of the Conservancy to bring about a combination scheme by the various authorities speaks volumes as to the necessity for some general drainage area being formed.

It has been shown in a former part of this memorandum that the separate action, particularly of the following authorities, has been altogether unsuccessful in properly dealing with the sewage of each district, and removing a nuisance which has existed for many years. To take the following examples:—

Hertford	Chemical Treatment.
Hoddesdon	Sewage Farm. A failure at times.
Wormley	The same.
Waltham Abbey	The same. Bad case.
Cheshunt	The same.
Enfield Lock. Royal Arms Factory.	Broad irrigation, Pollution at times.
Enfield Edmonton Walthamstow	In nearly all these cases where the sewage is treated by the land process, the farms have become thoroughly saturated and sewage sick. Pollution is caused to the River, and a great nuisance is created in the midst of very populous districts.
Leyton	Sewage treated by chemicals only. Not always successful.

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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The failure of the Conservancy to bring about a combination of action on the part of the local authorities in the lower end of the Lee Valley particularly points to the necessity for some big scheme being carried out jointly to rid these districts of a very bad and dangerous nuisance. The only remedy for this, so far as the Conservancy can see, is that the Local Government Board should promote a Bill to compel the authorities to combine to form a special drainage area, to deal with the sewage of the several districts in a complete manner, as indicated in the scheme laid down for the drainage generally of the Lee Valley.

WHAT ALTERATION IN THE LAW THE CONSERVANCY CONSIDER DESIRABLE FOR THE PREVENTION OF POLLUTION AND THE PROTECTION OF WATER SUPPLIES.

Dealing first with the case of Hertford, there is no doubt that Sections 7, 8, and 9 of the Act of 1854 should be repealed; also Sections 101 (Luton) and 105 (Tottenham) of the "Lee Conservancy Act, 1868"; and this could be done by a Bill promoted by the Local Government Board. The Hertford Corporation would then be placed on the same footing as the other towns and places in the Lee Valley, and could be dealt with under the general powers of the Board for the prevention of pollution, or by a Common Law action for nuisance, and could not shelter themselves under the clause which gives them power to turn their effluent into the river so long as it is treated by "the best known practicable process." It is found that, although an effluent may be discharged from sewage works apparently innocuous, after mixing with the river water and the chemical effect of certain vegetable growths, and secondary decomposition, the result is to cause a foul condition of the river.

The other point is, as indicated, for the Local Government Board to compel the authorities to combine and carry out some system of main drainage for the Lee and Stort Valleys, particularly having regard to the character of the neighbourhoods interested. Special financial provisions might be inserted in the Bill to ease the burdens of the local authorities by spreading the expense over a longer period of years. Such a course would be largely instrumental in reducing opposition to the scheme. This the Conservancy, after over 35 years' experience, consider the only practical remedy for insuring the purity of water from which something like one-third of the supply of the drinking water of London is derived.

GEO CORBLE.
Clerk of the Lee Conservancy Board.

Lee Conservancy Office,
12, Finsbury Circus, London, E.C.

20th October, 1903.

The following Reports are printed at the end of the volume:—

(1.) Report and Estimates on the proposed Lower Lee Valley Main Drainage and Sewage Disposal, May, 1902.

(2.) Report and Estimate, Intercepting Sewer and Sewage Disposal of Bishops Stortford, Thorley, Sawbridgenorth, and Harlow, July, 1902.

(3.) Report and Estimates of the Lee and Stort Valleys Main Sewerage and Sewage Disposal, October, 1903.

19024.* (*Chairman.*) We will now ask you some subsidiary questions, and hear any subsidiary statements that you may wish to make. In the first place, I should like to ask you to tell us generally what you expect us to do for you. You have come to us by your own request?—(*Mr. Hutchinson.*) Well, my Lord, in approaching you the question of the Conservancy is somewhat peculiar; they are in a somewhat peculiar position. For a very long time, having regard to the fact that the Lee is one of the principal sources of drinking water supplied to London, they have seen that the rapid increase of population and the consequent pollution of the river is a question that that being used in the future, and even to-day, as a source which is supplying at the present time not less than one-third of the drinking water of the whole of London. There are statements contained in the memorandum which has been placed before you showing how they have endeavoured to use the powers given to them by their Acts at least in one instance to obtain a satisfactory declaration as to what should be done to alleviate one very serious source of pollution—I mean the pollution of the upper part of the River Lee above the Intakes of the East London Water Company by the sewage of Hertford, and no doubt, as you have gathered, there are powers vested in the hands of a Government Department to order an inquiry the object of which would be to obtain a declaration as to what was the best known practical means, having regard to the circumstances, for the purification of that sewage. But the Government Department—the Board of Trade—have not seen their way, for reasons which they have stated in the correspondence—which I may say the Conservancy on their part do not regard as adequate reasons—to exercise the powers given them by the Acts of Parliament. And in the recent inquiry, in regard to this very sewage, where the Corporation were endeavouring to obtain a Local Government Board loan for the construction of certain works, the matter again came before not only the Board of Trade, but the Local Government Board; and, as you have seen by the letters which have passed between the Conservancy and the Government Departments, the Government Departments have rather sheltered themselves behind your Commission to discharge, perhaps, if I may say so, the duties that are rather thrown upon them by the existing law, and you will see that they say that we hope that the Royal Commission will make specific inquiry—I am giving the sense of the words they used—we hope that the Royal Commission will make specific inquiry as to what is the best known practical means that should be adopted by Hertford. Whether you have considered that a point of detail of that kind with regard to a particular district is a mtter which comes within the purview of your Commission at the present time, of course, I am not able to say, and I am not able, of course, to treat the matter from that point of view; but I do wish to impress upon the Commission on behalf of the Lee Conservancy that it does come within their general powers to examine into the condition of the pollution of the River Lee, and to say, if they so found that the evidence supported it, in their report that they think that the Lee stands in a peculiar position, and that although general measures for the alleviation of the pollution might be applicable to other watersheds, I will go so far as to ask you to say it is a matter for serious consideration whether the valley of the Lee should not receive some special treatment.

19024. May I ask whether you would put it in this general way that your object is to keep all sewage whatsoever out of the River Lee?—That, sir, is the ultimate object of the Conservancy.

19025. And you hope that we may be able to help you in obtaining that object?—Yes, if you thought that it would help the general question of improving the London water supply. I would ask you then to examine into the circumstances that obtain with regard to pollution on the Lee, taking into consideration the fact that I have said that the whole of the water of the River Lee is by Statute, with the exception of 5,400,000 gallons per day, vested in two water companies, and so the actual condition of things is this, that, whether we like it or not, with the exception of these 5,400,000 gallons of water a day, it is open to the two water companies to take every single gallon of water of the Lee, laden as it is with heavy sewage pollution, and supply it to the consumers of water in London. Now, we say, that is such a serious condition of things; it has been going on for so many years; it is by reason of the increasing population—rapidly increasing population of the Valley of the Lee becoming still more severe that we think that special measures ought to be taken here. We may say that the only measure that can adequately protect the Metropolitan water supply from the River Lee is the absolute exclusion of all sewage effluents from the river. I may even venture to point out to you this, that at the Inquiry at Hertford, where I had the honour to appear for the Conservancy cross examining the engineer for the East London Water Works Company, I put to him this emphatic question, "Looking at it (that is the purification) from an economic, scientific, and dietetic point of view, is it better to have partial prevention or absolute exclusion?" and he replied to that, "There can only be one answer to that, absolute exclusion."

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19026. Well, but supposing that you could have sewage altogether excluded, that would mean that a lot of water would be excluded also ?—It would.

19027. Would not that have a serious effect upon the navigation ?—I think not, because you see, my Lord, it is in this way, the quantity of water which is reserved for navigation has been already determined whatever might be the diminution in the quantity of water that would be passing down the River Lee, still that 5,400,000 gallons would require to be taken down. The quantity to be taken by the water companies for the purposes of the water supply is not a fixed and definite quantity, but it is any excess of that which is required for the purposes of the navigation, and that has already been determined that 5,400,000 gallons is sufficient.

19028. (*Sir William Ramsay*). Might I interrupt for a moment and ask if the water companies' intake would not be seriously prejudiced were all the sewage to be diverted from the River Lee ?—It would, Sir William, in this way, that they would be prejudiced that they would no longer be able to supply sewage for the purpose of water as they are doing now.

19029. In quantity ?—It would to that extent in quantity, the whole of the sewage that would be excluded from the river above the intakes of the water companies, of course, they would be deficient. Of course, at the same time they do not take their full quantity of water from the river now; they do not take the difference between the whole flow of the river and 5,400,000 gallons, so they would still have a margin to work upon. I do not know, my Lord, whether you have had this before you, the reports and estimates of the engineer to the Conservancy with regard to this Lee Valley sewer, which is intended to exclude the sewage, and if you would refer to the report, which is dated October, 1903, you will see some tabulated statements drawn out of the quantity of sewage and rainfall above the intake and below the intake. If you refer to the second table, you will see at the present time the dry-weather flow which would be excluded in 24 hours would be 1,207,000 gallons, so that Sir William would not be a very large quantity ?—No.

19030. (*Chairman.*) At the present moment you have no powers to exclude any sewage ?—No.

19031. You have nothing but the ordinary powers of the law to prevent contamination ?—With regard to the whole of the local authorities, with the exception of Hertford, we come under the provision of the general law. With regard to Hertford, they are in a special position. There is only an obligation upon them to purify according to the Higgs' process. That is the old lime process. Or upon a declaration of the Board of Trade obtained by the Conservancy, which I may again remind you the Board of Trade have not seen their way to make, the best-known practicable process.

19032. But how does that differ in practice from any other town, for example, you cannot prevent Ware, from sending their sewage into the river ?—No, so long as they conform to the provisions of the existing law. But that is where we say, my Lord, that we are handicapped as the Conservators of the river. Even the powers, the most stringent powers of the existing law are not sufficient, always having regard to the fact that the Lee stands in a peculiar position, that so large a proportion of the Lee—the whole flow of the Lee, you may say—is entitled to be taken for London water supply.

19033. Yes; but for the moment is there any real difference between the position of Hertford and the position of any other town ?—Yes, of course, if any other town transgresses we could.

19034. All you could do with the Ware sewage is to make the Ware people treat it in the best practicable way ?—Yes.

19035. You cannot keep it out of the river ?—We cannot keep it out of the river.

19036. Well, then there is very little difference between that case and Hertford ?—We could prosecute in the event of the effluent not being satisfactory in the case of Ware, but in the case of Hertford they are entitled still to use the old lime process unless we can show upon a certificate of the Board of Trade that there is some other process more practicable and better, and the Board of Trade have refused to hold that inquiry and to give that declaration. So that Hertford stands in this position, that if they choose now they need only adopt the lime process, and unless we get a declaration from the Board of Trade that there is a better and more practicable process our hands are tied. It is different in the case of Ware. If Ware were polluting by using the old inefficient lime process, our remedy is against them by injunction to show they are polluting; not so in the case of Hertford.

19037. (*Sir Michael Foster.*) Is not the question not of the "better" process, but of the best possible process ?—The best practicable process.

19038. Not simply a better one ?—Not a better one.

19039. But the best ?—The best known.

19040. (*Chairman.*) All our inquiries tend to show that the sewage effluent is almost as dangerous, if not quite as dangerous, to drinking water as the sewage itself, and therefore I should very much doubt whether any town gets what you would call an effluent absolutely safe to go into drinking water ?—My Lord, that has been the position that our scientific advisers have taken up for years. They have said, notwithstanding that all these towns may purify their sewage to the full extent that science is able to afford the means of doing, the pathogenic germs are not destroyed. The risk to the lives of the population that depend upon the water supply is not removed, and from that point of view, to use your own words, my Lord, drinking of the sewage effluent is practically as dangerous as drinking unpurified sewage, and it is for that reason that we have ventured to press this question of total exclusion of the whole of the sewage effluent from a source that is wholly allocated for drinking water.

19041. It is quite clear that you have objects in view which can only be attained by legislation ?—It is so, my Lord.

19042. And you hope that we may recommend such legislation as will enable you to carry out your object ?—If your Lordship would go to that extent, yes.

19043. You have come before us with that object ?—Yes.

19044. (*Sir Michael Foster.*) Your position then, I understand, is this, that no known process for the treatment of sewage will render the sewage effluent fit to be discharged into drinking water, and since the Lee is practically drinking water for the Metropolis the whole of the Lee Valley is to be treated in a special manner, namely, by the total exclusion of the sewage ?—Yes, Sir Michael.

19045. The difficulty which you are met with in the scheme which you are proposing is the want of compulsory power of various authorities to adopt that scheme ?—Yes.

19046. And that is practically what you are asking for ?—Yes.

19047. For legislation which throughout the whole of the watershed of the Lea will compel the authority to adopt a scheme, the essence of which is total exclusion of the sewage from the rivers ?—Yes.

19048. That is your position ?—That is our position; and it is with that hope that we come before you, that you will see from the memorandum which we have placed before you that such special circumstances exist that it deserves a special recommendation that something ought to be done.

19049. The special circumstance is really your contention that no process for the treatment of sewage will render the sewage effluent fit to be discharged into water used for drinking purposes ?—Yes.

19050. (*Mr. Power.*) You have reasons to be discontented with the methods adopted by other places besides Hertford in dealing with their sewage. You have chemical or bacteriological tests showing that they do not comply with the standard you have fixed to be observed ?—Oh, yes; and if you will refer, Sir, to the memorandum, you will find that there is a number set out extending over several pages, and I may just

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mention an instance that has lately occurred. It is within the recollection of the members of the Commission that the Government Powder Factories are situated at Waltham Abbey, above the intake of the East London water supply—some three miles above—and the cordite factory is also situated there. The Secretary of State for War is at the present time, only three miles above the intake, according to our view very seriously polluting the Lee. The chemist will tell you that he has found that such quantities of material (waste material) were run into the River Lee that when he evaporated it to dryness, it actually exploded, and we have no power at all against the Secretary of State for War. By Sections of the Lee Acts, he secures perfect immunity, and then I apprehend upon common law grounds we could not touch him at all, so that, so far as pollution is concerned from the Government Department at Waltham Abbey, we are perfectly powerless, and the water supply three miles above the intake of the East London Water Works Company is being polluted with the refuse material from the cordite factory.

19051. Is the pollution in large bulk, do you know, besides being offensive ?—Seven pipes, I am told, discharge. Mr. Young, who is here, I think has considered that the pollution is a serious element of pollution. Is that so, Mr. Young ? (*Mr. Young.*) The quality of the pollution.

19052. I suppose that it was the effluent from one of these pipes which exploded ?—(*Mr. Hutchinson.*) Yes ; not a sample from the river.

19053. These places which are named in the table to which you have just referred, I suppose most of them at your instance—at the instance of the Conservancy—have adopted measures for dealing with their sewage. Have they been urged to do so and pressed to do so, and are they still uniformly unsatisfactory ?—They have been pressed to do so, and in many instances they have endeavoured to comply to the extent of their ability, which of course is frequently measured by questions of finance, but our view is that the processes that are adopted, even the best of them, for the reasons which were indicated to me by Sir Michael Foster, are not sufficient, having regard to the special circumstance that the Lee is a source of drinking water.

19054. Notwithstanding that you have urged these people during a number of years to adopt the best known practicable methods ?—Yes.

19055. (*Sir Michael Foster.*) Might I ask, have you had a report as to the bacteriological condition of the Lee, in respect to its course above and below the intakes ?—No, there is none. The water companies will have that.

19056. Are you aware whether there has been any bacteriological examination ?—I am not aware, and I do not know whether the water companies' reports would show that ; whether they would show the bacteriological condition of the river, or the bacteriological condition of the water they supply just before it is supplied diluted with well water.

19057. But that is rather an essential point ; that is the crux of the whole matter, is it not ?—That is a very important point.

19058. (*Sir William Ramsay.*) I suppose your attempts to purify the Hertford sewage involved a considerable amount of expense ?—Yes ; on one occasion, as was pointed out in the memorandum, the Conservancy embarked upon litigation which cost them no less than £6,000, and which was entirely abortive.

19059. And that deterred you from proceeding against any other towns ?—As we are a poor body the lesson was sufficiently severe.

19060. You have been, I suppose, taking the best practicable course. You say you think that the whole of the sewage ought to be diverted and none of it flow into the Lee, but *faute de mieux* you have proceeded against towns in order to get them to adopt the best practicable means ?—Yes.

19061. But you wish, of course, that they should be prohibited from discharging any sewage whatever into the river ?—Our standpoint is that the best known practicable means is not sufficient for the Lee.

19062. On whom would the expense fall if such a course were adopted ?—On the local authorities who would make use of the sewer. Of course they would at the present time have to spend a certain amount of money in purifying. The amount that they expend in purifying, which I may remind the Commission is a very important burden upon a community, instead of being devoted to purification, which we say is useless, would be devoted to taking the sewage entirely away. No doubt it would add somewhat to the burden of the ratepayer, but we say ultimately not much, if anything at all, having regard to the increase of population, and if under the special circumstances Parliament should allow the expense to be spread over a term of 60 years instead of over only 30 years, the full term which the local Government Board is permitted by law to give, the expense would be greatly diminished.

19063. Do the ratepayers of the Lee gain any monetary benefit from the fact that their water is taken by the London Companies ?—Not one farthing.

19064. Then would it not be more just that the expense of purifying the Lee should fall on the water companies ?—The companies are not now in existence, the Metropolitan Water Board has taken their place.

19065. The Metropolitan Water Board ?—Then the burden would be thrown over the whole of London instead of over the communities which produce the sewage.

19066. But the object is to purify the London water ?—The object is to purify the London water.

19067. And is it fair to throw the expense of purifying the London water on a comparatively small district from which the London authorities derive their supply ? I think that is a matter, Sir William, for serious consideration. I may remind you that principle has already been recognised, because the water companies under the Lee Conservancy Acts are already compelled to contribute a sum of something like £2,000 a year to the expenses incurred by the Conservancy in preserving the purity of the water.

19068. Could that contribution be applied to the payment of interest on loans ?—I want to make myself perfectly clear, Sir William. The water companies pay a sum of money about £8,000 a year by way of water rents for the privilege of taking the water, and £2,000 a year for "Protection of Water" purposes.

19069. I am quite aware of that, but are these rents applied to cover interest and any permanent expenses incurred in diverting the sewage ?—Oh, no.

19070. So then, after all, the ratepayers of the Lee district would have to provide a large part of that sum ?—Yes. Of course the question comes in whether, having regard to the increasing requirements, the process of purification which they will be compelled to adopt would not be more burdensome and more costly by effluxion of time, but I am assuming that the processes that are adopted now cause a greater burden than the old-fashioned crude processes would have cost the community, and that of course is a factor which you must set off against the other circumstances which you have indicated in considering whether the burden of any additional expense should be borne by the whole consuming community of London.

19071. It appears to me to be a case for adjustment, and that the residents in the Lee district would be compelled to pay what they naturally would pay for the ordinary disposal of the sewage, but that any additional expense should fall upon the water works authorities ?—Yes.

19072. I should like to ask one question of Mr. Young. Perhaps he can possibly answer it. He spoke of the fact that the nitro-glycerine gets into the river ?—(*Mr. Young.*) Nitro-cellulose.

19073. The nitro-cellulose which gets into the river. Is it in a solid state or a liquid state ?—In suspension.

19074. Entirely in suspension ?—Yes.

19075. Are you aware of any experiments that have been made for the purpose of removing it ? I presume the suspended matter can be entirely removed by filtration ?—Quite so, yes ; it is easily removable by filtration.

19076. Nitro-glycerine, however, would not be wholly

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removable by filtration; there would be a certain part soluble ?—Yes. It seems to me there is a possibility of its being discharged.

(*Mr. Hutchinson.*) I should just like to say, Sir William, pursuing the question you put to me whether the extra expense of exclusion might not be borne by the water consuming community, it has to a certain extent been recognised in principle, because I have just remembered that the New River Company undertook works at their own cost in the neighbourhood of Hertford to the extent of something like £40,000. In addition to that, lower down the river the East London Water Company have incurred a large expense upon the construction of what they call the special intercepting drain, in order to take the sewage water which comes from defective sewage farms below the intake. Your principle has been recognised by the London Water Company to that extent.

(*Sir William Ramsay.*) Thank you.

19077. (*Colonel Harding.*) From what source do these various communities above and below the intake which you refer to in these tables get their water supply? Do they get it from streams which fall into the Lee, or do they get it from wells or from a distance ?—(*Mr. Hutchinson.*) From a variety of sources, Colonel, but the majority of them get it from the wells.

19078. In the same shed ?—In the same water-shed And many of these wells are not deep wells, and do not go into the chalk, but derive their water mainly from the surface strata.

19079. Then am I right in concluding that the water withdrawn from these shallow wells would naturally find its way if it were not so used into the stream of the Lee ? —I think it would. Some, of course, are in the chalk; but with regard to those that are in the chalk in the higher part of the water-shed it has long been a disputed question, particularly in Parliamentary water enquiries, whether some of that water does not pass already into the Lee through springs in the bed of the Lee, but as the position stands at present they draw their water-supply from wells, the water of which in many cases would directly pass into the river, and that water after being used by them is now passed into the river as sewage.

19080. Some of them who do not draw from wells probably will derive their supply directly from streams that flow into the Lee, or possibly from the River Lee itself ?—Only in the smaller communities, the villages and people of that kind.

19081. Should I be right in taking it that the water supply which is used by these various communities is water which would naturally fall into the Lee ?—Yes, in the majority of instances.

19082. Then I would like to ask you, and this is the object of the questions that I have been asking you, whether the withdrawal of the 40,000,000 gallons of water a day which you estimate would be the amount withdrawn at the present time, or whether the withdrawal of 100,000,000 gallons a day, which is the ultimate amount you expect will have to be withdrawn—whether so large a withdrawal of water which naturally would flow down the Lee will not affect very seriously the navigation of the Lee, and largely reduce the volume of its flow ?—Well, I am informed by the engineer that these are circumstances which he and those who are associated with him have taken into their serious consideration, and after examining into the whole of the circumstances they do not consider that the proposal for an exclusion sewer would at all injuriously affect the navigation of the Lee.

19083. (*Sir Michael Foster.*) Or the drinking supply ? —Or the drinking supply.

19084. Because there have been times, have there not, when the supply from the Lee has been below what it ought to have been ?—Yes.

19085. (*Colonel Harding.*) And that, may I take it, has been carefully gone into, and it is clearly understood that the withdrawal of so much as 100,000,000 gallons during the 24 hours would not adversely affect the Lee in any way ?—Mr. Tween says that is so. (*Mr. Tween.*) Yes.

19086. (*Sir Michael Foster.*) Should we have in very long dry seasons an ample supply of water for the districts of London that are now supplied by the Lee ?—(*Mr. Hutchinson.*) So it is considered.

19087. (*Colonel Harding.*) The Lee is not an important stream, is it ?—An important stream ?

19088. Yes ?—From what point of view ?

19089. Well, what is the size of the Lee at Ware ? What is the width of the stream there ?—(*Mr. Tween.*) Between 50 and 60 feet, Sir.

19090. Is it deep ?—We maintain about five feet.

19091. Have you ever estimated what at exceptional times of flow is the volume of the stream ?—The New River Company take an average of 22,000,000 gallons a day from the river at Hertford, and in addition to that we pass down the quantity necessary for navigation.

19092. Then can you give us any idea of the amount of the flow that you pass down for navigation ?—In dry weather I should say we pass, roughly, about 1,000,000 gallons for navigation, and they take 22,500,000 gallons. (*Mr. Hutchinson.*) May I just interpose a moment, Colonel ? If you will refer to that table again upon which you based your question you will see that the 100,000,000 gallons to which you directed my attention is not sewage, but it is sewage and rainfall.*

19093. I quite appreciate that, but it is water, polluted water which you propose to divert from the River Lee to some point very much further down ?—Yes.

19094. To a point in fact close to the confluence with the Thames ?—Yes.

19095. In other words it is a large volume which you propose to withdraw from the River Lee and to take away from the useful purpose which it now serves ?—It may be more valuable.

19096. Will you explain that ? — (*Mr. Tween.*) You will see the dry weather flow from Walthamstow and Leyton; Walthamstow 7,000,000 and Leyton 5,000,000. That all flows into tidal water. It does not flow directly into the navigation, it flows into back streams running into Stratford and then down to Bow Creek.*

19097. You said that is included ?—It is included in the total, Sir; it does not affect the navigation.

19098. Therefore the withdrawal would not be so important as I suggested ?—Yes.

19099. I think it is necessary to ask you these questions, because I remember that on a former occasion when it was proposed to carry an intercepting sewer of this kind it was said it meant ending the existence of the stream. I do not suggest that this means ending the existence of the Lee as a river, but I was rather anxious to find out whether it would at all seriously affect the navigation of the Lee for general purposes ?—In dry weather, the flow we propose to intercept above the intakes would be only 2,700,000.

19100. Then the object of carrying out the scheme would be to get a better river by improving the condition of the River Lee ?—Yes.

19101. But your objects are not exclusively for the purposes of water supply ? I mean you are not coming before us to-day on behalf of the East London Water Company ?—(*Mr. Hutchinson.*) No. We act in the interests of the general health of the whole inhabitants of the water-shed.

19102. Then we are to gather that your idea in desiring to see a scheme of that kind carried out is that you do not think there are sufficient practical means of purifying the sewage ?—Such is the evidence we have been enabled to gather.

19103. At Hertford they have what you refer to as the somewhat old-fashioned system of chemical precipitation ?—Yes.

19104. Do you know of any improvement upon that or of any modern progress in the direction of sewage disposal which would bring about better results than that from chemical precipitation ?—Well, that of course, as we say, is a duty that was cast upon the Board of Trade, and the Board of Trade have said, "No, we won't decide it, we want you to go to the Royal Commission to decide it for us."

19105. But before you come to the Royal Commission to decide this or before you ask the Board of Trade to decide it for you, had you not as a Rivers Conservancy thought it necessary to make enquiries on your own

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* *See* Reports at end of Volume.

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account as to the most recent and improved methods which might have been brought out for sewage disposal?—Yes, so we had; but what is the position, we are powerless to enforce them.

19106. Then the position is that you do know of better means of sewage disposal than the antiquated one of Hertford, but you are not able to make your authorities adopt them?—Given that we had a free hand to select a process which we considered would give the best known practical results, we could go to Hertford and do better than they are doing now, but even then we say that if Hertford water is to be used for the purposes of drinking water in London, we know of no process that will make the Hertford Sewage harmless, totally harmless, for the purposes of drinking water.

19107. You mean you know of no process that would absolutely withdraw the bacteria from the effluent?—Yes.

19108. But is it necessary to go to the point of absolute withdrawal, is it not possible to reach some point which would be sufficient? I do not know if you are aware that it was proposed—you probably know much more than I do about it—it was proposed to have sand filters as the final process of dealing with the sewage effluent at Hertford?—Yes.

19109. And have you any knowledge how far sand filtration, if it is effectively carried out, will reduce the number of bacteria in the effluent?—I believe that sand filtration will materially reduce the number of bacteria, but sand filters are liable to accident, and one accident even for a few hours will pollute the whole water supply to the east of London and result in disaster. As we regard it, Colonel, in the one case you are trusting to something that may go wrong, and from one isolated instance disaster may follow. In the other case, the means that we consider would be the best, having regard to the special circumstances, were absolutely secure.

19110. What I am trying to find out is whether even in your own minds there is not some practicable alternative to this scheme of carrying an intercepting sewer right away to Leyton, and I ask myself whether in view of the population, representing only about 370,000 persons, and it being spread over a very considerable area, it is not possible for these various communities, by adopting a modern and effective system of sewage treatment, to bring about so considerable a purification as would relieve the waters of the Lee from the danger with regard to their water supply provided always that there is filtration by the water companies?—Well, if I may put it in a rough and ready way this is not one of the cases wherein with a multitude of counsellors there is wisdom. If we could induce the whole of the authorities to adopt precisely the same process, and that process one which had been ascertained to have given a practically perfect result, I think that our case would be weaker; but when I assure you that we are dealing with an innumerable, a comparatively innumerable number of communities, all of whom have different views, we never know where we are.

19111. Is this scheme that you are approving itself thoroughly practicable? It proposes to add, does it not, from 10d. to over 13d. in the pound to the rates of these various districts?—I do not know whether it proposes to add that to the rates.*

19112. On the last page of the document which has been placed in my hands, I find the table upon which the expenses of the scheme are worked out, and it is suggested that if a loan is borrowed for thirty years the rate would be 13¼d.; and if borrowed at 60 years, or part of it borrowed at 60 years, the rate would be 10½d. in the pound?—That is the total rate for the whole of the sewage disposal. At the present time a considerable portion of that is paid, and in many instances, no doubt, exceeded by the present methods of disposal.*

19113. Then you think that the cost of this scheme would be actually in some places possibly less than the authorities would be put to if they carried out separate schemes?—That is our view, and as the population is rapidly increasing and the value of property is also rapidly increasing, the burden of course would become proportionately diminished in relation to the increase of population.*

19114. (*Sir William Ramsay.*) Then you have no further expense?—No further expense. That is our view.

19115. (*Colonel Harding.*) With regard to the question of the purity of the Lee the results which have been brought about are fairly satisfactory, are they not, even from the point of view of the pure water supply by the East London Water Company?—I believe the water examiners say so.

19116. And, therefore, if each of these communities were to carry out a sufficient system of sewage treatment we may imagine that the results of analyses of the East London Company's water supply would be still better?—Our view is that there you are trusting to a broken reed; you are trusting to something that may go wrong at any moment; a small accident may quickly grow into a big disaster.

19117. (*Sir Michael Foster.*) Is your scheme perfectly free from all possible accidents?—According to our view, yes; because the whole of the sewage is absolutely removed from the river.

19118. Your sewer might leak?—It would not leak into the river, it would leak into the surrounding ground.

19119. And thence into the river?—Ultimately.

19120. (*Colonel Harding.*) None of the ground over which you propose to carry your sewage is mined ground, is it?—None.

19121. Is it sound ground?—Sound ground.

19122. Is it liable to subsidences of any kind?—No.

19123. You do not apprehend any trouble with the sewage?—No, I think not. The subsidence of sewers is absolutely an unknown factor.

19124. Then in carrying this flow away from your own midst to the neighbourhood of the outfall from the valleys of the Thames, you are throwing this burden really on the Thames?—We are admitting the sewage which of course would be treated in the same way that the sewage of London is now treated into a huge volume of tidal water.

19125. You think no nuisance or difficulty is likely to arise from adding to the original burdens of the Thames this additional burden?—Our view is that in that direction there is nothing to be apprehended. I may remind you that the condition of the Thames since remedial measures have been adopted by the Metropolitan Board of Works and the London County Council have shown immense improvement as regards its sanitary condition.

19126. Is an objection likely to be made by the Thames Conservancy or any bodies interested in the neighbourhood of the Thames at your proposed outfall to the scheme which you are proposing?—That of course we cannot say, but I should apprehend not, because at the present time I may remind you that of the whole of this volume of sewage a large portion of it, as we say, is unpurified at all, and goes into the Thames several miles higher at Blackwall, where the flow of the Thames is not nearly equal to what it is at the proposed point of discharge. So that as far as the interests of the Thames are concerned, it would be a transference of something that actually exists now in a thickly-populated neighbourhood into a larger volume of tidal water where there is no population at all.

19127. But it would be proposed of course that this great flow through an intercepting sewer should be treated near its outfall in an effective way?—Yes, not less effective than the present means adopted by the London County Council.

19128. Would not that be liable to accident in the same way as you suggest? An independent sewage works would be liable to accidents?—It might be, but that accident would be inconsequential.

19129. It would be very much more serious, would it not?—I think not.

19130. Since it might possibly stop the purification of this huge flow of sewage?—Perhaps I misapprehended you. Did I understand an accident to the process of purification?

19131. You said to me in answer to a previous question that your objection to independent sewage works at these various places was that they were liable to get out of order. Well, would not this big sewage works of yours be equally liable to go out of order?—It might be. But it would not be accompanied by the same results. In the one there is danger to health and danger to life; in the other no such danger. The discharge is not into a supply of drinking water but it is practically into the sea, and then I may remind you that the total discharge of the sewage into that huge volume of tidal water would be only some 24 millions a day, and that would be excessively small; it is a negligible quantity compared with the tidal flow at the point of discharge.

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* *See* Reports at end of Volume.

19132. That is probably the dry weather flow ?—The dry weather flow.

19133. But the pollution would be very considerably more; in fact it would be a hundred millions ?—But I suggest the polluting factor is the same whether it is dry weather or wet weather flow.

19134. I am not quite sure you are right there, Mr. Hutchinson. Are not the subsequent dilutions themselves as polluting as in the dry weather flow ?—If it is used as a source of drinking water, yes; if it is turned into a tidal volume, no.

19135. But, surely, whether it is used for one purpose or the other does it not affect the amount of pollution brought down by dilution ?—We look at the question of pollution in relation to the use to which the stream is put into which the sewage is discharged. A pollution that would be an inconsequential and negilgible quantity and not worth taking notice of in a stream not used for drinking water would be a serious thing in the case of a stream used for drinking water.

19136. Then have you any likelihood of obtaining the consent of all these various authorities to the large intersecting sewer ?—To the consent of some of them, yes; to the consent of the whole of them, no; and that is one of the main reasons which has induced us to come here to obtain from you, as the Lord Chairman has put it, an expression of opinion which would be of use to us, in order to enable us to get powers which would compel these local authorities to unite upon some such a scheme.

19137. Then briefly you think, that in a case like this of the Lee, where the withdrawal by intercepting sewer of a large volume would not affect the navigation or the utility of the river or any purpose it is best, instead of the local authorities carrying out the sewage purification works to have it done wholesale at some point lower down ?—Yes.

(*Sir William Ramsay.*) Will you allow me to put one question ?

(*Chairman.*) By all means.

19138. (*Sir William Ramsay.*) Have you considered the possibility of sterilising the outfall of sewage effluents, and making it compulsory not merely that the best known methods of purification should be adopted, but that the whole of the sewage effluents should be sterilised before they go into the Lee ?—We have hardly thought that this is within the region of practical politics.

19139. I am not at all sure it is not; it is merely a question of expense—what would cost least ?—Total exclusion would cost least as far as our present knowledge is concerned.

19139*. (*Sir Michael Foster.*) Have you gone carefully into the various methods of sterilisation ?—Perhaps Mr. Young will answer that question.

19140. Or is it simply a chemical sterilisation ?—(*Mr. Young.*) I know the processes are in operation in several places.

19141. Do you know the Maidenhead process ?—The sterilisation process.

19142. Is that the process adopted at Maidenhead ?—No, Sir, it was used at West Ham and has been disused now for some years. It was a precipitation process, known as Wollheim's, in which lime and herring brine were used, and by which the effluents were rendered perfectly sterile, but after exposure for a day or two they became putrid.

19143. Is your opinion of sterilisation based merely upon that particular process ?—No, I have no opinion upon sterilisation; I do not profess to have an opinion.

19144. (*Sir William Ramsay.*) We have very good evidence that it would cost something like £1 per million gallons to sterilise the ordinary better class sewage effluent. Would that make it possible to complete with your suggested main drainage scheme ?—From the money point of view ?

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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19145. From the money point of view ?—I am not able to express an opinion.

(*Mr. Hutchinson.*) £1 per million gallons a day, reckoning on 24 million gallons, would mean £25 a day, and that would be about £9,000 a year.

(*Mr. Young.*) £13,000.

(*Sir William Ramsay.*) Yes, it would be close upon £13,000 a year.

(*Mr. Hutchinson.*) £13,000.

19146. Well, taking it at that, is that anything like the cost to which you are put ?—We estimate the working expenses at £14,000.*

19147. Of course this would not do away with the necessity of purifying in the ordinary way. You have to get a reasonably good sewage effluent first; it would be an additional cost of £13,000 ?—Then I think there is no question on the figures placed before you, that the absolute exclusion would be absolutely the most economical.*

19148. (*Sir Michael Foster.*) I am not sure how in your scheme you propose to deal with the storm-water ?—Storm-water. Mr. Tween, will you tell the Commission. You take the present scale of dilution before discharge at six volumes.

19149. What proportion of the storm-waters are you proposing to take into your sewers ?—Will you answer that question, Mr. Tween ? (*Mr. Tween.*) Six volumes of the dry weather flow. The sewer is designed to carry six volumes of the dry weather flow.

19150. And the rest would go straight into the drinking water ?—The rest would be dealt with as storm-overflow-plots down the valley. If the sewer was overcharged, if it ever did get so.

19151. That is stated in your report, is it ?—(*Mr. Hutchinson*). What page is that on about the storm-plots ? (*Mr. Tween.*) Storm-plots are not put into the report.

19152. You propose to adopt a separate system ?—Yes.

19153. So a great deal of the storm-water then would go direct into the river ?—Down from the roads and so on.

19154. And that is bacteriologically most objectionable, is it not ?—(*Mr. Hutchinson.*) To the same degree ?

19155. I won't say to the same degree, but I mean you are exposing yourself. There is evidence that ordinary storm-water of that kind does contain or may contain a very considerable number of bacteria ?—Doubtless.

19156. So that your drinking water would not be under those conditions, absolutely beyond suspicion ?—The scheme, of course, to that extent would not be perfect.

19157. (*Chairman.*) I should just like to ask you whether you have had any communications with the new London Water Board ?—Well, my Lord, I was going to say that one of the members of the Lee Conservancy who attends before you here to-day, Mr. Barnard, is a member of the Water Board, and I was going to suggest to your Lordship whether there might not be some question connected with the relation between the Conservancy and the Water Board which might be put to Mr. Barnard, and I should also like to say that another member of the Conservancy, who is present here to-day, Mr. Nield, is a member of the Middlesex County Council, another important body with whom the Conservancy, of course, have relations with regard to the purity of water.

19158. I think the Commission would be glad to hear any remarks that these gentlemen may wish to make ? (*Colonel Harding.*) My Lord, before we pass on to that, may I just ask for information which I think may be useful to this Commission. What is the policy of the Lee Conservancy in regard to trade effluents ? Is the Lee valley one in which there are very few manufactories ? —Compared with some of the other rivers in regard to which you have considered this question, the trade effluent question in the Lee is not so important a question as the one of the sewage from sewage works.

19159. (*Sir Michael Foster.*) Is it not increasing Mr. Hutchinson ?—I was going to say that in the lower part

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* *See* Reports at end of Volume.

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of the valley of the Lee the manufactories are rapidly increasing.

19160. I see from the railway as I travel on it a very large building being put up by Sir John Brunner, or that he is connected with ?—Yes, so that the question of trade effluent will become more pressing in the future than it is at the present moment.

19161. (*Colonel Harding.*) What is the policy of the Lee Conservancy with reference to manufacturing pollutions ? Do they find they can readily stop them. Have they the necessary powers, and can they exercise those powers without undue delays, and in fact, are they able to secure the stoppage of manufacturing pollutions ? —In the majority of instances we have been able to deal by amicable means with manufacturers, and to secure the river against any serious pollution from that source. Of course, with the exception of the one I specially mentioned, that they have no power to deal with.

19162. That is the Royal Enfield Works ?—The powder factory.

19163. But I should say that the trade effluents from such a manufactory would not be important, would it, though the domestic sewage might be, but that particular factory would not be likely to turn out any trade effluent which would trouble you, would it ?—You will see in the chemist's report in the memorandum that he regards that pollution as rather a serious thing.

19164. Is it a trade pollution ?—Well, it is a trade pollution really.

(*Mr. Yonge.*) There is the manufacture of small arms and cordite.

19165. (*Colonel Harding.*) I should not have expected that you would have had any great difficulty in stopping trade pollution ?—There is no great difficulty, but, of course, the ordinary friction occurs. There is difficulty in bringing pressure to bear on them, but I might say we have had no great difficulty in stopping that source of pollution.

19166. Will you tell me what has been the policy of the authorities in your district as to receiving trade effluents into the sewers ?—They take them.

19167. Upon conditions ?—That question I am not able to answer. No conditions.

19168. Upon payment ?—No, I am told no payment. Of course, I might point out that the manufacturing part of the Lee is almost wholly confined to the tidal portion of the Lee, to the portion below the water company's undertaking.

19169. Have you breweries at Hertford ?—It all goes into the sewers.

19170. (*Sir Michael Foster.*) But are not the manufactories increasing above the tidal portion ? Have not several new manufactories been started above the tidal portion ?—I think, Sir Michael, you may say that the manufacturing community is rapidly increasing the whole of the way up from Tottenham to Waltham Abbey.

19171. That is above the tidal portion, of course ?—That is above the tidal portion. The major portion of it is below the intakes.

19172. (*Colonel Harding.*) Do you consider that your powers with regard to stopping manufacturing pollution are sufficient ?—We went to Parliament, I think, in 1900, and we obtained provisions then that remedied defects that were known to exist before.

19173. What is the course that you take ? Do you give notice to the manufacturer that he is polluting the stream and call upon him to abate, and what is the next thing if he does not do it ?—There are no separate sewers from these factories running into the river, I am told.

19174. You cease to deal with the manufacturer and deal with the local authority ?—We seek to deal with the manufacturer.

19175. May I ask you this final question, whether from your experience of the Lee Board in the Rivers District, it is advisable that their effluent should be dealt with by the Conservancy rather than by the individual traders themselves ?—We think that the manufacturing effluent would be better dealt with by the authorities and discharged through the public sewers.

19176. (*Chairman.*) May I ask, Mr. Barnard, whether you are in favour of the Lee Conservancy's scheme ?—I am in favour of a general scheme of this character.

19177. Do you think that the body you represent would view it favourably ?—They have done so, and, further than that, for a period of 30 years the previous members of a similar body called the Trustees or the Conservancy Board, as the case might be, from time to time have done the same thing, and they have placed on record through Parliamentary Committees their adhesion to this as practically the best solution of dealing with their river.

19178. Have you any views as to whom the cost of this action would fall on ?—I have very strong ones. I consider that the local authorities should be called upon up to the point of the intake of the water companies to bear the cost which they might reasonably be asked to bear to bring their water up to the condition required by the Rivers Pollution Act, and when they go beyond that then the persons who would gain through the improved quality, namely the water consumers, the water companies or the Water Board should be called upon to pay that difference. Following the question that this gentleman asked, there are three or four illustrations of where the water companies have already done this. The New River Company, to a very large extent, diverted this self-same Hertford sewage that Mr. Hutchinson has spoken about, and in that diversion at a huge cost they agreed to pay the Hertford Corporation a contribution of £600 a year for the maintenance of their sewage works. This they have done for 34 years, and are doing to-day. Well, they carried this intercepting drain called the Manifold Ditch beyond their intake Well, besides that, the East London Company has in three instances, I believe—they first of all had to alter their intake from somewhere in the neighbourhood of Lee Bridge, and in doing that they made an intercepting drain from Ponder's End to Tottenham. They subsequently altered the intake again, and they made another intercepting drain or added to the present one which carried off the sewage of Cheshunt beyond their intake. Now to-day they have found that the outcome of this Manifold Ditch at Hertford was so dreadful that they have made a contract—the Hertford Corporation with the East London Company—to carry out the whole of the Hertford sewage works for a period of 30 years, they receiving from the Corporation the sum of £700 a year for so doing, the effect of that being this, that one water company pays Hertford £600 a year, and Hertford pays to the other water company £700 a year, so that the net result is a cost to Hertford of £100 a year, to be relieved of its sewage by the two water companies, and the East London Company is wishing to spend—they are prepared to spend—a sum of £30,000 at the present moment in order to deal with this sewage. Well, it is in connection with that, roughly speaking, that we are here to-day. We protested that the method they proposed to adopt was not efficient.

19179. (*Sir William Ramsay.*) Might I ask who these are of whom you are speaking ?—The Conservancy Board. They protested before the Local Government Board inquiry that the scheme was not efficient, and the Report shows it went through various Government Departments until it was referred here, so that my contention is that it affords an illustration that the water companies have contributed for such a purpose, and therefore they ought to contribute or the owner of the water ought to contribute whatever is his proper proportion of the cost which the local authority can be called upon to bear under the Rivers Pollution Act.

19180. (*Chairman.*) What will be the position with the New London Water Board ? Will Hertford pay them £700 and receive from them £600 ?—Exactly. The new Water Board will step absolutely into the shoes and the contracts of both companies. As I understand it, I am a member of the Water Board, the Board has no contract of that character, so that on balance it will simply mean wiping one off and the payment by Hertford of £100 a year for 30 years.

19181. Then the new Water Board itself has not yet considered this scheme ?—In no shape or form, excepting this ; that I understand that when the time comes next week for the commencement of the arbitration between the Companies and the Water Board, the Water Board will advance the theory that either the Lee, as a source of supply must be abandoned, or else welcome the preription that we are advocating to-day is the urgent nd imperative necessity, and that the water companies hould be debited with the amount required for this purpose, as otherwise they could not be selling an article that was pure.

19181.* You think the Water Board is going to advance that ?—I believe so ; I gather so. I should like to say this, if I may, I have no authority to speak for the Water Board in any shape or form, but I am called as a witness by the Water Board, and in the proof which I have sent in, which I understand they accept, that theory is advanced. It is clear I am only speaking for myself.

19182. (*Sir Michael Foster.*) You believe that will be the attitude of the Water Board ?—I believe so.

(*Chairman.*) Well, gentlemen, I do not know whether there is anything more that any of you wish to say ?

(*Mr. Nield.*) All I am going to say is this. I come here by the authority of the Middlesex County Council. We have, of course, an interest in this river so far as our very large populations around the banks are concerned. The county of Middlesex begins at Clapton and runs away on the western bank of the river right up beyond Enfield, and the populations have abnormally increased—the populations at Tottenham and Edmonton. The last census as compared with the previous one shows an alarming increase, if I may say so, of working-class people. The place is spreading very rapidly ; it is almost wholly covered in certain parts of Edmonton with small buildings occupied by people who require protection in matters of this sort. I would also like to say, my Lord, a number of deputations were formed to wait upon each one of the authorities before whom the upper and the lower schemes have been put and, as instancing the very great pressure the County Council of Middlesex, who had no power at that time to promote a Bill in Parliament, were given the power by the Local Government Board in this way, that they were promised not to be surcharged in the event of the Bill not going through in 1898 when, in consequence of the shocking condition of the river Brent, it became necessary to take some steps, so I do mention that as showing that the authorities are alive, as they should be alive, to the necessity of purifying streams in proximity to the large urban population, and that nothing short of a scheme of this sort can possibly relieve the danger which threatens these large working-class populations along the banks of the river. There was a very serious epidemic of small-pox at Tottenham in 1898 ; in Enfield and Tottenham and Edmonton it was extremely severe, which was due to the offensive smell from time to time arising from the leakage from the Enfield sewage farm. In times of flood, and there have been a great many floods this year, the whole of this district has been water-logged and sewage has been absolutely seen to float upon the surface, and but for the question of cost there is no doubt that Edmonton would have been very glad to adopt the scheme. In Enfield they spoke very favourably of it, and on the whole it had an extremely favourable reception.

19183. Then we may take it from you that the Middlesex County Council are in favour of a scheme of this sort ?—Oh, perfectly.

(*Mr. Barnard.*) I would like to say one thing, my Lord, and it is this—briefly it has been mentioned here to-day—what makes the matter so much more difficult now is that the East London Company have formed, I think, two enormous reservoirs that practically impound between 2,000,000,000 and 3,000,000,000 gallons of water. They have further got powers up to 7,000,000,000 or 8,000,000,000 gallons. Well, now, these reservoirs are fixed nearer to London, more in the neighbourhood of Tottenham, but no doubt the effect is they can only be filled in flood time, and all our sewage farms, throughout the length of this valley, I believe every one of them, were simply flooded more than once this year with this Hertford sewage. I myself went and saw it. The navigation we will say is *there ;* the Manifold ditch *here*, and the New River *here*, and all three were one level sheet of water—all three of them. Many of us in this room saw it flowing simply one level mass of water, and all the sewage farms throughout the valley were overflowing right into the stream, rushing headlong down to the East London intake. Now, if I am not troubling you, what I want to speak of is this, that all through the piece from about 1866, when they began taking from the Lee, these water Bills and things of that sort have been brought along. They have been proposing reservoirs at different times, and they propose the reservoirs to be near where the gauge is of the River Lea at the mouth of the Stort, and all the engineers from 1866 down to 1870 were saying that the reservoirs ought to be located in this part, and that there must be no junction between the reservoirs and the intercepting drain. Well now, what has happened ? We have come to the year 1900 and, instead of there being the reservoirs placed in a more or less safe position up the valley, they have been placed lower down after this cordite factory has been put up. For the last 15 years all these different things are all in front of the reservoirs and the intercepting drain which these early men in 1870 said was necessary. The reservoirs in the rural part have not been made, and you have got the reservoirs in the worst part without any intercepting drain. Well, the effect of it all is that as a Conservancy Board we are absolutely powerless to prevent this flood water going down there ; and, further than that, when we come to ask approval of this scheme what happens ? The water company have objected to pay the money. Under "Lee Conservancy Act 1900" they have to contribute £2,000 a year to the Conservancy funds for the purposes of protecting the valley against pollution. Well, we took every sort of opinion ; we were advised that we could not promote a Bill, and that we could not use our funds for the purpose. We were, further than that, stopped and attacked by the water companies, whose representatives put resolutions on our agenda that we should not go on trying to do it, and when we went to the expense of this scheme, our reason being that we knew that the local authorities would be more likely to consider some tangible material thing if we took it up for them to criticise ; we went to the expense of getting out these plans, and then when it comes to the question of the auditor passing our accounts the water companies object to our paying this money, and it has been referred to a gentleman who perhaps will not look into it now, Mr. Alfred Lyttleton, to be the arbitrator to decide between us and the water companies, so what I want to put to you is that the East London Water Company is seeking in every possible way to impede us, the reason being practically concentrated in the question of what you gentlemen asked, the question of quantity versus quality. If the quality is improved, as we want it, it will take away from the quantity of the liquid that these people are getting for their business purposes.

Mr. C. C. Hutchinson, Mr. G. Corble, Messrs. Clapham and Fitch, Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H Nield.

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(*Chairman.*) I think I need only say that we shall be glad to consider what you have said to us and what you have laid before us, but, of course, you must understand in the first instance that we cannot make any promises whatever and, secondly, that we are a body that have no powers at all. We can only make recommendations, and those recommendations may or may not be accepted by the Government.

(*Mr. Hutchinson.*) My Lord, I have to thank you for your great kindness and courtesy in hearing us.

(*The Representatives of the Lee Conservancy then withdrew.*)

LETTER and ENCLOSURE subsequently received from the Lee Conservancy.

Lee Conservancy,
12, Finsbury Circus, London, E.C.
October 26th, 1903.

PROTECTION OF WATER.

SIR,

I am directed by the Lee Conservancy Board to send herewith, for the information of the Commissioners, a copy of the Report of their Engineer presented on the 23rd instant, with regard to the sewage of the towns of Cheshunt, Waltham, and Bishop's Stortford, as instances of the liability of the river to pollutions in times of severe rainfall, when the pumps at the various sewage farms are unable to cope with an excess of storm water.

I am, Sir,
Your obedient servant,
GEO. CORBLE,
Clerk.

F. J. Willis, Esq.,
Secretary of the
Royal Commission on Sewage Disposal,
29, Victoria Street, S.W.

Mr. C. C. Hutchinson. Mr. G. Corble, Messrs. Clapham and Fitch. Mr. C. N. Tween, Mr. W. C. Young, Mr. R. B. Croft, Mr. E. B. Barnard, and Mr. H. Nield.

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EXTRACTS from the Sanitary Report of the Engineer of the Lee Conservancy Board, dated October 23rd, 1903.

Cheshunt Sewage Farm.

During the recent heavy flood the engine ceased pumping at 6 p.m. on the 11th instant, and started again at 7 a.m. on the 12th, stopped again at 6 p,m. on the 12th and started again at 6 a.m. on the 14th, but the sewage was flowing from the overflow pipe at the pumping station into the effluent pipe from 6 p.m. on the 11th instant until 7 a.m. on the 16th, and the whole of the sewage was passed by way of the storm outlet pipe into the intercepting drain at Ponder's End, and thence to the Lee at Tottenham.

The engines were kept pumping day and night since 6 a.m. on the 14th, but they did not gain control of the flow of sewage until 7 a.m. on the 16th, when the plug was put in the overflow pipe.

Waltham Abbey Sewage Works.

The sewage pumps at these works ceased pumping at 6 p.m. on the 11th instant until 6 a.m. on the 14th, but the engines did not gain control of the sewage until 11.30 a.m. on the 14th, when it ceased flowing into the ditch behind the pumping station.

During this period the whole of the crude sewage was passed by way of the storm overflow pipe direct into the ditch and thence to Cobbin's Brook and the Lee.

It will be remembered I reported the same thing occurred in the June floods. This is a most serious matter, as being only about three miles above the intake of the East London Waterworks Company, the water must have been considerably polluted.

I hope the Board will take serious notice of this matter, and, if possible, press for a heavy penalty.

Bishop's Stortford Sewage Works.

The sewage pumping engines at these works again broke down on the 13th instant, at 2 a.m. for four hours, during which time the sewage was passed through the storm coke filters and thence by the night flow pipe direct to the River Stort below Twyford Lock.

Our water bailiff stated that on the 15th instant the pipe was discharging full bore. It will be remembered the same thing occurred on September 22nd.

Mr. R. Philipson, Mr. F. A. W. Drummond, and Mr. C. E. Groves.

Mr. R. Philipson, Secretary of the Thames Conservancy called in, and Examined; together with Mr. F. A. W. Drummond, the Chief Inspector, and Mr. C. E. Groves, the Analytical Chemist.

19184 (*Chairman.*) You come before us representing the Thames Conservancy, and I should propose that the paper which you have submitted should go straight on to our minutes ?—(*Mr. Philipson.*) Yes, my Lord.

(A) The Constitution of the Board.

The Conservators of the River Thames were incorporated in 1857, by an Act passed in that year.

Thames Conservancy Act, 1857 (20 & 21 Vict., c. 147).

Their jurisdiction extended from Yantlet Creek to the City stone, above Staines Bridge, a distance of 78 miles. Under this, the original Thames Conservancy Act, the Board consisted of twelve members.

Thames Conservancy Act, 1864 (27 & 28 Vict., c. 113).

In 1864 a further Act was passed which added six members, making a Board of 18.

Thames Navigation Act, 1866 (29 & 30 Vict., c. 89).

The Thames Navigation Act passed in 1866, which extended the Conservators' jurisdiction up to Cricklade in Wilts (a total distance of 203 miles), added five members to the Board, making 23 in all.

London County Council (General Powers) Act, 1893 (56 & 57 Vict., c. 221).

The London County Council (General Powers) Act, 1893, added seven members, making 30 in all.

Thames Conservancy Act, 1894 (57 & 58 Vict., c. 187).

The next permanent alteration in the constitution of the Board was made in the year 1894. The Thames Conservancy Act, passed in that year, amended the constitution of the Board, and fixed the number of Conservators at 38, viz.:

31 appointed and seven elected as follows :—

Appointed :—

By the Admiralty	2
By the Board of Trade	2
By the Trinity House	2
By the Gloucestershire and Wiltshire County Councils, or by one of those Councils	1
By the Oxfordshire County Council	1
By the Council of the City and County Borough of Oxford	1
By the Berkshire County Council	1
By the Council of the County Borough of Reading	1
By the Buckinghamshire County Council	1
By the Hertfordshire County Council	1
By the Surrey County Council	1
By the Middlesex County Council	1
By the London County Council	6
By the Common Council	6
By the Essex County Council	1
By the Council of the County Borough of West Ham	1
By the Kent County Council	1
By the Metropolitan Water Companies	1
	31

Elected :—

By shipowners	3
By owners of sailing barges, lighters, and steam tugs	2
By dock owners	1
By wharfingers	1
	38

This is the present constitution of the Board.

(B) The Conservators' Powers in Regard to Pollution.

The Thames Conservancy Act, 1894, consolidated, amended, and extended the statutory powers of the Board.

The Conservators consequently derive their powers for the prevention of pollution from this Act.

The provisions relating particularly to pollution are contained in Sections 90 to 108.

Origina powers their ex tension

Before describing the powers now exercised by the Conservators, it may be convenient to notice when purification powers were first conferred upon them, and how these have been gradually extended.

Thames Conserv Act, 18 & 21 V 147).

Thames Conserv Act, 18 & 28 V 113).

The original Thames Conservancy Act (1857) contained a clause (Sec. 102) making it an offence to throw rubbish, &c., into the Thames, or to allow any offensive matter to flow into the river; and the Thames Conservancy Act, 1864 (Sec. 74) conferred further powers in this direction, making it an offence to discharge gas liquor, trade refuse or other offensive matter into the Thames, or into the tributaries within three miles from the main river. No special mention was made of sewage pollution, and these Acts only referred to the river below Staines.

Thames Naviga Act, 18 & 30 V 89).

Thames Conserv Act, 18 Vict., c

Thames Naviga Act, 18 & 34 V 149).

The Thames Navigation Act, 1866, was the first legislative enactment which prohibited the passage of sewage into the Thames. Its provisions applied only to the district above Staines, but in the following year the pollution powers were extended by the Thames Conservancy Act, 1867, down to the western boundary of the Metropolis at Chiswick; and subsequently by the Thames Navigation Act, 1870, to the river (and the tributaries for a distance of three miles) below the Metropolis.

So far as the tributaries are concerned, the Act of 1866 only gave the Conservators jurisdiction for three miles up the streams. This distance was increased to five miles by the Act of 1870, and to ten miles by the Act of 1878.

Such were the limits within which the Conservators exercised jurisdiction for pollution purposes up to the year 1894.

ssion, politan , 1892.

The Royal Commission on the Metropolitan Water Supply, 1892, in their report, referred to various hindrances which stood in the way of effectual action by the Conservancy Board, viz.:—

(1) Their limited jurisdiction (10 miles from Thames).

(2) The cumbrous procedure under their Acts.

(3) Their inadequate staff of inspectors, in consequence of the limited funds at the Conservators' disposal.

With a view to the removal of these hindrances the Commissioners recommended:—

(a) That the Conservators' jurisdiction should be extended to the whole course of the tributaries.

(b) That their Acts should be simplified.

(c) That the inspection staff should be very considerably increased, the necessary funds being provided by the Water Companies.

al) Act, 6 & 57 . 221).

The London County Council (General Powers) Act, 1893, imposed upon the Conservators the duty of introducing a Bill into Parliament in the ensuing session, for the consolidation and amendment of the Conservancy Acts, so far as the constitution and powers of the Board were concerned.

s vancy 94 (57 ict., c.

In the event of the Conservators failing to introduce such Bill, the London County Council were authorised to do so.

The result was the introduction of a Bill by the Conservators in the following year, and the passing of the Thames Conservancy Act, 1894.

THAMES CONSERVANCY ACT, 1894.

Under this Act, the Conservators' powers for the prevention of pollution were greatly extended:—

ion of of va-

(1) The area of jurisdiction above the Metropolis was increased from 1,740 to nearly 4,000 square miles, the 10 mile limit up the tributaries was abolished, and practically the whole of the Thames watershed, above London, was brought within the scope of the Act. (The jurisdiction below London remained as before).

(2) The time allowed under the notices requiring discontinuance of pollution, was reduced from twelve months to three months.

(3) Powers were given to board vessels in the Thames above Teddington, for the inspection of their sanitary arrangements.

(4) Procedure under the Act was rendered easier by making it an offence to pollute a tributary irrespective of whether the pollution was, or was not, likely to reach the Thames.

The object in view is shown by the preamble of the Act which recited that having regard to the large quantities of the waters of the Thames used for purposes of domestic supply in the Metropolis and suburbs, and the constant increase of population and of sources of pollution in the catchment area, it is expedient that the powers of the Conservators for preventing pollution should be enlarged and made exerciseable over an extended area.

POLLUTION CLAUSES OF THE ACT.

on Act

The following is a brief analysis of the Pollution Clauses:—

on ord ary.'

Section 90.—States the district within which the Conservators exercise their powers, and defines the word "tributary," viz., any river, stream, watercourse, cut dock, canal, channel, and water in the counties of Gloucester, Wilts, Oxon, Bucks, Berks, Hants, Surrey, Middlesex, Herts, Essex and Kent, and the County of London, being within the catchment area of the Thames and communicating directly or indirectly with the Thames, except:—

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(a) So much as is more than three miles from the Thames of any tributary below London.

(b) The River Lea and its tributaries.

(c) Cuts, docks, or canals belonging to dock companies established under authority of Parliament, or companies owning docks, within the Port of London.

Scavenging, &c.

Section 91.—Casts upon the Conservators the duty of maintaining the flow and purity of the river, and of scavenging the surface of the river, and of the tributaries within three miles of the Thames, down to the western boundary of the Metropolis.

Throwing and depositing rubbish &c.

Section 92.—Prohibits the throwing, or allowing to fall, of rubbish, ashes, refuse from gas or other manufactories, &c.:—

(1) Into the Thames or on to its shores.

(2) Into any tributary within three miles so that the same will, or may be, carried into the Thames.

(3) In any place where the same is likely to be carried by floods or extraordinary tides into the Thames.

Also prohibits:—

(4) The allowing of any washing from making gas, or any other offensive matter, solid or fluid, to pass into the Thames or into any tributary.

(Vessels in the Port of London and under the jurisdiction of the Port Sanitary Authority are excluded from the provisions of this Sub-section.)

(5) The depositing and allowing to remain more than 48 hours, any collection of manure ashes, &c., &c., on banks of the Thames or the tributaries (within three miles) so that it will be likely to drain, be blown, or pass into the Thames or such tributary.

Penalty for the offence, not exceeding £20; and daily penalty £10.

Section 93. Prohibits:—

Prohibiting the opening up of sewers, and the passage of sewage into the River and its tributaries.

(1) The opening up of any sewer, drain, &c., whereby sewage or other offensive or injurious matter shall, or is likely to flow to the Thames or its tributaries.

(2) Causing or allowing any sewage, &c., to pass into the Thames or its tributaries through any sewer, drain, &c.,

Penalty for offence, not exceeding £100; daily penalty ditto, £50.

Section 94. Provides:—

Notice for discontinuance of pollution (*see* Form A.).

(1) For service of notice requiring the discontinuance of any such pollution within three months.

See Form B.

(2) For extensions of time being granted by the Conservators, should they think fit.

(3) For disputes as to extensions to be settled by arbitration.

(4) Penalty for non-compliance with notice, not exceeding £100; daily penalty, £50.

(5) For removal of proceedings into the High Court.

Section 95. Provides:—

Notices to affect successive owners, &c.

That notices requiring discontinuance of pollution shall continue in force notwithstanding,

(a) Any temporary or partial suspension of the flow of sewage, &c.

(b) Any change in ownership or occupation of land or premises,

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Re service of copy of renewal. Notices in certain cases.

Section 96. Provides :—

For service of a copy of renewal notice respecting pollution from manufacturing premises, not situated in a town, where no proceedings have been taken by the Conservators for three years after service of the original notice.

Re Notices under former Act.

Section 97. Provides :—

That notices served under former Acts shall continue in force.

Power to enter lands and open up the ground (*see* Form C.)

Section 98. Empowers :—

Conservators' officers, on producing a certificate of authority to enter lands or premises for the purpose of examining and laying open the same, and in event of admission being refused, to obtain an order from a Summary Court of Jurisdiction.

Penalty for disobeying order, £5.

Provisions are made for land to be made good and restored, also for compensation for damage done in certain cases.

This section does not apply within limits of the Port of London under the jurisdiction of the Port Sanitary Authority.

Sanitary Authorities to afford information.

Section 99. Requires :—

Sanitary authorities and owners and occupiers of land to produce plans and furnish information as to ownership or control of sewers and drains passing through their lands.

Penalty for making default, £5.

Power to stop up outlets of sewers, &c.

Section 100. Empowers :—

Conservators after conviction of any person under Section 93 or 94, to stop up outlets of sewers, drains, &c., and to carry out necessary work and recover expense incurred.

Penalty for obstruction or hindrance, £20.

Exemption in respect of certain drains, &c., below Teddington.

Power to board vessels on Thames above Teddington (*see* Form D.).

Section 101. Authorises :—

Conservators' officers on producing, if required, a certificate of authority to board and inspect vessels in Thames above Teddington, to ascertain whether the sanitary arrangements are satisfactory.

Penalty for obstruction or hindrance, £5.

Re weed cutting.

Section 102. Requires :—

Persons cutting or employing others to cut weeds, &c., in the Thames or tributary to immediately remove such weeds, &c., from the stream, and prohibits the throwing or sweeping of grass, &c., into any stream.

Penalty for offence, £5.

Right to prosecute in Conservators only.

Section 103. Enacts :—

That no other persons other than the Conservators' officers, attorneys, solicitors, or agents shall institute proceedings or prosecutions under the clauses of the Act relating to pollution.

Act not to legalise any nuisance.

Section 104. Enacts :—

That nothing in the Act shall legalise any nuisance or prejudicially affect any existing remedy as against persons causing or suffering pollution.

West Ham Corporation.

Section 105.

Saves rights of West Ham Corporation in respect of their outfall near West March Sluice in River Lea.

Protection of cultivation of watercress.

Section 106.

Protects rights of watercress growers to use streams, &c., and open drain pipes or channels for passing water through their beds into any tributary.

Medway Conservancy.

Section 107.

Saves rights of the Medway Conservancy.

For protection of Victoria Steamboat Association.

Section 108.

Provides that Section 92 (4) and Section 101 shall not apply to vessels of the Victoria Steamboat Association or their successors when engaged as passenger steamers below Moulsey Lock.

Forms of Notice above referred to.

FORM A.

THAMES CONSERVANCY.

To ....

WE, THE CONSERVATORS OF THE RIVER THAMES, in pursuance of the provisions of the 94th Section of the "Thames Conservancy Act, 1894," 57 & 58 Vic., Cap. clxxxvii., HEREBY GIVE YOU NOTICE that we require you to discontinue within three months from the date of the service hereof the flow or passage of sewage or any other offensive or injurious matter whether solid or fluid into the ....
....
from the Sewers, Drains, Pipes or Channels at ......
....

DATED this ...... day of ....
One Thousand ....
....

Secretary of the Conservators
of the River Thames.

Thames Conservancy Office,
Victoria Embankment, London, E.C.

FORM B.

THAMES CONSERVANCY.

To ....

WHEREAS WE, THE CONSERVATORS OF THE RIVER THAMES, gave you Notice in writing on the .... day of .... requiring you to discontinue within three months from the date of the service of such Notice the flow or passage of sewage or any other offensive or injurious matter whether solid or fluid into ....
....
from the Sewers, Drains, Pipes or Channels at ......
....

AND WHEREAS application has been made by you to us for an extension of the time specified in the said Notice for such discontinuance as aforesaid, and such application having been duly considered by us, WE HEREBY GIVE YOU NOTICE that under and by virtue of the powers reserved to and vested in us by the "Thames Conservancy Act, 1894," 57 & 58 Vic., Cap. clxxxvii., Section 94, WE do herby extend the time specified in the said Notice for such discontinuance as aforesaid, for a further period of Three Months, from the .... day of ...., the date of the expiry of the said Notice.

DATED this .... day of ....
....

Secretary of the Conservators
of the River Thames.

Thames Conservancy Office.
Victoria Embankment, London, E.C.

FORM C.

THAMES CONSERVANCY.

THE CONSERVATORS OF THE RIVER THAMES, in pursuance of the powers of Section 98 of the Thames Conservancy Act 1894 (57 & 58 Vict., Cap. clxxxvii.), and for the purpose of giving effect to the provisions of the said Act relating to Pollution, hereby authorise ....
from time to time and at any time between the hours of nine in the forenoon and four in the afternoon to enter upon any land or premises for the purpose of examining and laying open the same.

DATED this .... day of 190

By Order,
Secretary of the Conservators
of the River Thames.

Mr. R. Philipson, Mr. F. A. W. Drummond, and Mr. C. E. Groves.

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FORM D.

THAMES CONSERVANCY.

KNOW ALL MEN, that We, the Conservators of the River Thames, do by this writing under the hand of our Secretary, authorise and appoint .... to board and inspect vessels in the Thames above Teddington Lock, for the purpose of carrying into effect the provisions of Section 101 of the Thames Conservancy Act, 1894.

Dated at the Thames Conservancy Office, Victoria Embankment, London, this .... day of .... 190......

By Order,

....

Secretary of the Conservators
of the River Thames.

NOTE.—By Section 101 of the Thames Conservancy Act, 1894, any person who obstructs or hinders any Officer of the Conservators in the exercise of the power conferred by that Section, shall, for every offence, be liable to a penalty not exceeding £5.

Signature of the officer named above.

....

BYE-LAWS.

Of the bye-laws made by the Conservators under the provisions of Sections 191 of the Act, the following refer to the work of river purification :—

Bye-law 76.

Prohibits passage of sewage or other offensive or injurious matter into the Thames from any vessel above Teddington Lock.

Bye-law 77.

Provides that every houseboat or launch on Thames above Teddington Lock shall be provided with such sanitary arrangements as have been approved by the Conservators' officers, and no such vessel shall be registered until it is shown a satisfactory method exists thereon for the disposal of sewage and refuse.

Bye-law 80.

Prohibits the casting or throwing, &c., in or about the river, or on to the banks or towing paths, or on the Conservators' land, any sewage, rubbish, or other offensive or injurious matter or thing.

(C.) METHOD OF WORK ADOPTED BY THE CONSERVATORS FOR CARRYING INTO EFFECT THEIR POWERS FOR PREVENTION OF POLLUTION.

For the efficient inspection and supervision of the extended area within which Conservators now exercise jurisdiction, they have divided the area into eight Districts, viz. :—

No. 1 *District.*

The Upper Thames down to Eynsham, with the Windrush, the Evenlode, the Ray, and smaller tributaries.

Area, 789 square miles.

No. 2 *District.*

The main stream of the Thames from Eynsham to Day's Lock, near Wallingford, the Valleys of the Cherwell and the Ock and smaller tributaries.

Area, 444 square miles.

No. 3 *District.*

The main stream of the Thames from Day's Lock to Staines, the Valleys of the Thame and Wye, and smaller tributaries.

Area, 653 square miles.

No. 4 *District.*

The Valleys of the Kennet, the Pang, and the Loddon.

Area, 777 square miles

No. 5 *District.*

The Valley of the Colne.

Area, 356 square miles.

No. 6 *District.*

The Valleys of the Wey and the Bourne Brook

Area, 408 square miles.

No. 7 *District.*

The Thames from Staines to the western boundary of the Metropolis, the Valleys of the Brent, the Mole, and other tributaries.

Area, 365 square miles.

No. 8 *District.*

The Thames from the western boundary of the Metropolis (Chiswick) to Yantlet Creek, the Wandle, the Roding, the Darent, and smaller tributaries.

Area, 587 square miles.

Inspecting Staff.

Outdoor Staff—Chief Inspector, Inspectors and Assistants.

For the inspection of the Thames and the tributaries within these districts the Conservators have appointed the following outdoor officers —

One Chief Inspector.

One Inspector for each district.

One Assistant Inspector for each district.

also one additional Assistant to assist the Chief Inspector in the work of sampling, carrying bottles, &c., or 18 Inspectors in all.

Where Inspectors are stationed.

As at present fixed, these officers reside at or in the neighbourhood of the following towns :—

The Chief Inspector ..	Kingston.
No. 1 District	Cirencester.
No. 2 District	Oxford.
No. 3 District	High Wycombe.
No. 4 District	Reading.
No. 5 District	Uxbridge.
No. 6 District	Guildford.
No. 7 District	Kingston.
No. 8 District	Greenwich.

Duties of Outdoor Staff.

Duties, Chief Inspectors.

The Chief Inspector is appointed to exercise a general supervision of the District Inspectors and their Assistants.

See instructions to Inspectors, page 168.

It is his duty to acquaint himself with the working of their different districts, to pay surprise visits with the view of satisfying himself that the officers carry out their duties efficiently. Also to satisfy himself as to their conduct and behaviour, the manner in which they keep their journals, letter books, papers, &c. It is also his duty to examine their journals and accounts.

The Chief Inspector has to deal with any cases requiring special attention, and to investigate complaints.

Inspectors and Assistants.

The District Inspectors and Assistants are appointed with the object of detecting and preventing the discharge of sewage or any other offensive or injurious matter into the Thames and its tributaries from—

See instructions to the District Inspectors and Assistant Inspectors, page 168.

Towns,
Villages,
Mills and manufacturing premises,
Outlying premises,
Farm-yards, pigsties, &c.,
From Vessels.

Speaking generally, it is their duty—

(*a*) To examine and watch all places where it is known pollution has occurred.

(*b*) To discover causes hitherto undetected.

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It is also their duty—

(1) To take samples periodically for analysis
  (*a*) of effluents from sewage works,
  (*b*) of river water,
and samples of any discharges of sewage or offensive matter from any sources, as they may consider necessary.

(2) To scavenge the surface of the river and of the tributaries for three miles above the W. boundary of Metropolis, causing removal of dead animals or floating impurities, or substances liable to putrefaction.

(3) To report any cases of the throwing of rubbish, ashes, &c., into the river, or into its tributaries within three miles, also cases where rubbish, manure, &c., are improperly deposited near the streams.

(4) To board, and inspect sanitary arrangements on vessels on the Thames above Teddington Lock.

(5) To report all cases where vessels are cut and allowed to float down stream, and where weeds, grass, or other vegetation are thrown or swept into the river and tributaries.

(6) To report monthly, showing result of all inspections during the preceding month, distinguishing between:—
  (*a*) Sewage works or sewage farms of towns, &c.
  (*b*) Other places or premises where pollution exists.
  (*c*) Places where the results of their examination have been satisfactory.

(7) To visit all parts of their districts each month.

(8) To keep a journal of their proceedings and the duties performed each day.

Inspectors supplied with certificates of authority.

With a view of showing that the officers are duly authorised servants of the Board, they are furnished with certificates authorising them:—

(1) To enter lands for the purpose of examining the drainage arrangements, and, if necessary, opening up lands.

(2) To board vessels on the Thames above Teddington Lock.

Distances travelled by Inspectors.

The average distance travelled per man by the Inspectors and Assistants during the six months (July to December, 1902) works out as under:—

	Bicycle.	Train.	Foot.	Total.
Miles ..	3,183.	788.	603.	4,574.

Analysis of Samples.

Analysis of samples.

The number of samples taken and analysed amounts to about 2,500 per annum.

These include:—

Particulars *re* samples taken.

(*a*) *Periodical Samples*, viz., from sewage works at towns and villages, and from paper mills and other manufacturing premises where there are works of a more or less systematic character for dealing with refuse and drainage. These periodical samples are taken, as a rule, once every two months.

(*b*) *Special Samples*, taken as may be found necessary from the above, or from any other sources from which pollution may reach the river.

(*c*) *River Water Samples.*—These include samples taken periodically from the river at points above the intakes of the water companies; also samples from the Thames at points below where the various tributary streams join the main river, with the view of showing how the main river is affected by the inflow from the tributaries.

Instructions to Inspectors.

THAMES CONSERVANCY.

INSTRUCTIONS TO CHIEF SANITARY INSPECTOR.

1. The Chief Inspector is appointed to exercise a general supervision over the District Inspectors and their Assistants.

2. The Chief Inspector will be supplied with a map defining the limits of the different districts; also with a list of towns, villages, and places which should be kept under observation by the Inspectors.

3. It will be the duty of the Chief Inspector to acquaint himself as opportunity may offer with the working of the different districts and to go into each district at least once a month.

4. The Chief Inspector is to pay surprise visits to the different districts with the view of satisfying himself that the Inspectors and assistants carry out their duties efficiently and in accordance with their instructions.

5. The Chief Inspector is to satisfy himself as to the conduct and behaviour of the Inspectors and Assistants, and that they keep their journals, letter books, papers, etc., in a proper manner, and it will be his duty to examine their journals and accounts.

6. It will also be the duty of the Chief Inspector to deal with any cases requiring special attention, and to investigate any complaints which may be made against the Inspectors or the Assistants. He will also carry out any additional duties which may from time to time be allotted to him.

7. The Chief Inspector is to make reports on the above to each meeting of the Committee.

By order of the
CONSERVATORS OF THE RIVER THAMES.

24th February, 1896.

THAMES CONSERVANCY.

INSTRUCTIONS TO THE DISTRICT INSPECTORS AND ASSISTANT INSPECTORS.

1. Limits of the district.

2. The District Inspector is to reside at

or such other place as the Board from time to time may direct.

3. It will be the duty of the District Inspector to make himself thoroughly acquainted with the provisions of the Thames Conservancy Act, 1894, relating to the prevention of pollution.

4. The District Inspector is to devote the whole of his time to the duties of his office, and is not to take any other occupation. He is also strictly prohibited from taking fees, gratuities, or remuneration from any person whomsoever.

5. The District Inspector is appointed with the object of preventing the discharge into the Thames and its tributaries within his district of sewage or any other offensive or injurious matter, whether from town or village drains, houses, farmyards, pigsties, or any other source. It is necessary he should be on duty every day (including Sundays and general holidays when so required), and that during each month he should visit all parts of his district, in such order as he may judge necessary; examining places from which it is known that pollution has found its way into the streams, and doing all in his power to discover cases hitherto undetected.

6. The District Inspector is to make a monthly report showing the result of all his inspections made during the preceding month, and distinguishing—
  (*a*) Inspections made of sewage works or sewage farms of towns or other places;
  (*b*) Inspections of places or premises where pollution exists;
  (*c*) Inspections of places or premises where the result of his examination has been satisfactory.

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7. The District Inspector will be provided with a map of his district, on which will be marked the various towns and villages from which it is likely pollution may reach the river or its tributaries. It will be the Inspector's duty to visit all the places so marked, reporting to the Conservators the result of his inspections.

This map has been marked with the view only of assisting the Inspector in detecting sources of pollution, and it must be understood that it does not profess to show all sources from which pollution reaches the streams. It will be the duty of the Inspector to detect all such sources.

The Inspector is to report specially once every six months whether every place in his district has been examined.

8. The River Inspector on the Thames, within the limits of this district as above defined, has instructions to bring to the notice of the District Inspector any cases of pollution in the main stream and its backwaters which may come within the River Inspector's observation, but this is in no way to be taken to lessen the responsibility of the District Inspector.

9. The District Inspector is to take samples of effluents from sewage works, or of sewage or other offensive or injurious matter discharged into the river or its tributaries within his district, as often as may be necessary, and further once in every two months to take special samples of the effluents from sewage farms or sewage works, and of the water from the river and tributaries, as well as at various times to take such samples from the river when the water is very high or very low, and otherwise to take samples as ordered. The samples shall be in bottles, carefully sealed and labelled, and it shall be specified when and where and by whom they were taken; and they are then to be forwarded to the analyst.

10. The District Inspector is to take steps to cause the surface of the Thames and its tributaries within three miles of the Thames to be effectually scavenged, and is also to cause the removal from the river and from the tributaries within the distance aforesaid of any dead animals and other floating impurities or substances liable to putrefaction.

11. It is the duty of the District Inspector to report al cases which may come to his knowledge of ballast, mud, rubbish, refuse from gas works or other manufactories, or any of the substances mentioned in Section 92 (subsection 1) of the Thames Conservancy Act, 1894, being thrown or allowed to pass into the Thames or into any tributary within three miles of the Thames; also all cases of any of these substances being deposited in any place where they will be likely to be carried by floods into the Thames. The Inspector will also call attention to any heap of manure, ashes, or other offensive matter which may be deposited on the banks of the Thames or its tributaries within the distance aforesaid, so that the same will be likely to drain, be blown, or pass into the stream. It will also be his duty to report cases where any washing or other substance produced in making or supplying gas, or any other offensive matter, whether solid or fluid, is allowed to pass into the Thames, or into any tributary, whether from vessels or from any other source.

12. The District Inspector will be provided with a certificate authorising him to board and inspect vessels in his district in the Thames above Teddington Lock for the purpose of carrying into effect the provisions of Section 101 of the Thames Conservancy Act, 1894.

The Inspector is empowered by this section to board and inspect any vessel on the Thames above Teddington Lock, at any reasonable time, once in every year, and at any other time when he has reasonable cause to suspect that any alteration has been made, since the last inspection, in the sanitary arrangements of the vessel. This power is granted to enable the Conservators by their officers to ascertain whether any sewage or other offensive matter, whether solid or fluid, is passing or can pass into the Thames from such vessel.

The District Inspector is to keep a watch on houseboats, launches and other vessels with a view to detecting any such pollution, and he is to report immediately any case where sewage or other offensive matter reaches the stream from any such vessel.

13. The District Inspector will be furnished with a certificate authorising him to enter any land or premises, subject to the restrictions contained in Section 98 of the Act, for the purpose of examining the sanitary and drainage arrangements, and, if necessary, laying open such land or premises.

The Inspector, however, will not proceed to open up any land or premises until he receives special instructions so to do.

14. The District Inspector is to see that the precautions mentioned in Section 102 of the Act as to cutting weeds are duly attended to, and he is to report immediately any cases where weeds are cut and allowed to float down the stream, or where any weeds, grass, or other vegetation are thrown or swept into the Thames or its tributaries.

15. The District Inspector is to keep a journal of his proceedings stating exactly each place visited by him, and the duty performed on each day. This journal is to be submitted to the River Purification Committee at their first meeting in each month, or at any other time when directed. The journal to be entered up every day.

16. As a rule, the District Inspector is not to enter into correspondence with the public, but to refer all matters to the Conservators, and when it becomes essential for him to write letters, he is to make copies thereof in a book. He is also to keep in a guard book all letters received by him.

17. The Assistant appointed by the Board will reside at

and be under the orders of the Board and of the District Inspector. The Inspector and the Assistant will carry out the same class of work. The Assistant is to fulfil the duties of the District Inspector in the absence of the latter. Arrangements should be made for an interchange of work, so that both Inspector and Assistant shall become acquainted with all the places within the district.

18. The Assistant Inspector is subject to all the above instructions in so far as they relate to the duties to be performed by him.

By order of the

CONSERVATORS OF THE RIVER THAMES.

17th December, 1894.

Indoor Office Staff.

Indoor Staff.

The office work in connection with river purification is carried out under the direction of the Secretary, the River Purification Branch being a branch of his department, and a complete history of every case and record of each inspection and analysis is kept.

River Purification Committee.

River Purification Committee.

The work of river purification is dealt with by a standing committee of the Board, the River Purification Committee, to whom all matters of importance are referred.

Meeting.

The Committee meet fortnightly, reporting to the Board the result of their deliberations.

The usual course when a case of pollution is reported is to—

(1) Write to the person or body responsible. Should the desired effect not be produced by correspondence,

(2) Serve the formal notice prescribed by the Act, requiring discontinuance of pollution within three months, and, if in a reasonable time no steps are taken to meet the requirements of the notice,

See print of Notice submitted.

(3) To refer the case to the solicitor to enforce compliance with the Act.

Experience and policy of the Committee.

Experience has, however, shown that in the great majority of cases it has been possible to secure compliance with the Act without having recourse to legal proceedings.

The carrying out of new drainage schemes, especially at towns and centres of population, necessarily involves time; the preliminary steps, the difficulties of deciding between competing schemes, in raising the money, and in selecting suitable sites for works, have all to be taken into consideration.

The general principle adopted is not to unduly harass or press communities which show a genuine desire to

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Cost of pollution work.

meet the requirements of the Act, and the Conservators have always exercised the greatest care and discretion in the administration of the far-reaching powers entrusted to them by Parliament.

Finance.

It was estimated at the time the Thames Act, 1894, came into force, that there would be available for the purposes of river purification work, the sum of £6,500 per annum, viz. :—

£4,000 for the Upper Navigation above Staines, and

£2,500 for the Lower Fund.

Since that date another district (the Lower River—No. 8 District) has been formed, and two additional Inspectors appointed to carry out the duties.

The expenditure on river purification work for the year 1902 was :—

	£	s.	d.
Lower navigation - - -	2,860	10	1
Upper navigation - - -	3,872	12	9
	6,733	2	10

Results :—

The following information gives some idea respecting :—

(*a*) The results of a year's work, and

(*b*) the position of matters at the end of last year at the principal places where the drainage had not been placed on a satisfactory basis.

During the year 1902 pollution was diverted from the streams at 17 towns and villages, representing a population of near 30,000. These places, at which works are now in operation, include :—

Chipping Norton,	
Eynsham,	Oxfordshire.
Kingsclere,	Hampshire.
Kings Langley,	Hertfordshire.
Hillingdon,	
Ruislip,	Middlesex.

At most of the places where pollution still existed, sewage disposal works were being carried out, and in many instances were nearing completion, notably at :—

Witney,	Oxfordshire.
Wantage,	Berkshire.
Marlborough,	Wiltshire.
Rickmansworth,	Hertfordshire.
Leatherhead,	Surrey.
West Drayton,	
Potters Bar,	Middlesex.

Works were on the point of being started at :—

Watlington,	Oxfordshire.
Amersham,	Buckinghamshire.

Schemes had been prepared by the local authorities at the under-mentioned places, but had not, up till the end of 1902, met the requirements of the Local Government Board :—

Hungerford,	Berkshire.
Burford,	Oxfordshire.
York Town,	Surrey.

At Aylesbury, the works constructed proved incapable of dealing with the sewage in times of excessive rainfall, and plans for an extension of the works were under consideration.

The inspection of outlying premises including :—

Farms,
Isolated residences,
Manufacturing premises,

was carried out, with the result that pollution was diverted in 216 cases.

Houseboats and launches using the river above Teddington were inspected, with the view of ensuring that the sanitary arrangements were satisfactory.

The surface of the river and tributaries down to the western boundary of the Metropolis was scavenged.

Attention is also called to the fact that during the year 1902 there were :—

Inspections made in the Thames Watershed -	21,000
Samples analysed - - - - - -	2,439

The Analyst's report being as follows :—

——	Bad.	Not Bad.	Good.
1,077 effluents from sewage works at towns and villages - - -	107	670	300
179 effluents from works dealing with isolated residences - -	70	79	30
326 effluents from works dealing with refuse from manufactories -	50	154	122
561 other discharges - - - - - - - - - -	141	270	150
296 samples of water from the River and tributaries - - -	20	215	61

General Results :—

The work accomplished during the eight years since the passing of the Act of 1894 may be briefly summarised as follows :—

——	Above the Water Companies Intakes.			Below the Water Companies Intakes, but above the Western limits of the Metropolis.		
	Places.	Population.	Percentage of whole Population of Places Inspected.	Places.	Population.	Percentage of whole Population of Places Inspected.
A.—No pollution discovered - - -	618	194,305	17·4	33	14,445	2·3
B.—Pollution diverted - - - -	516	836,756	75·0	76	595,936	94·1
C.—Pollution in course of diversion -	44	80,749	7·2	11	24,410	3·4
D.—Pollution not diverted - - -	4	3,791	0·4	1	1,448	0·2
	1,182	1,115,601	100	121	633,239	100·

Note.—(1) Sewage works of a more or less systematic character have been carried out at 140 towns and villages.

(2) Pollution has also been diverted in 2,349 individual cases (isolated residence, farms, manufactories, &c.).

District below the Western Boundary of the Metropolis.

Any results based on population would be misleading as regards this portion of the Conservators' district, which includes the whole of London (under the control of the London County Council). Moreover, many of the important cases dealt with are factories, mills, &c.

The following statement shows the results of the Conservators' operations at the principal places in this portion of their jurisdiction:—

Places below the Western Boundary of the Metropolis.

Sewage disposal works are in operation at the following places, and the effluents are generally satisfactory:—Mitcham, Wimbledon, Barking, Romford, Leigh, and the West Kent Main Drainage Works at Dartford (dealing with Bromley, part of Beckenham, Orpington, St. Mary Cray, St. Paul's Cray, Foot's Cray, Chislehurst, Sevenoaks, part of Bexley and Dartford).

The effluents from the Metropolitan outfalls at Barking and Crossness are watched, and the London County Council communicated with as necessary.

The following is the position of affairs at other places in respect of which the Conservators have served notices:—

Coldharbour District of Blackwall. Bridge Road District of Poplar.	These places are about to be drained into the Metropolitan sewers.
East Ham.	The local authority are seeking Parliamentary powers to connect the drainage with the Metropolitan system; meanwhile they are carrying out improvements at their sewage disposal works.
Ilford.	The local authority are seeking sanction to borrow £24,000 to improve their existing sewage disposal works.
Dagenham.	The Local Government Board recently declined to approve a drainage scheme submitted to them. The local authority are being pressed to deal with the drainage.
Rainham.	A drainage scheme is under the consideration of the Local Government Board.
Erith.	Sewage disposal works are in operation, and the work of connecting premises with them is nearly completed.
Crayford.	Recently drained to the West Kent Main Drainage Works.
Grays.	Improvements at the sewage disposal works are on the point of completion.
Gravesend and Milton.	The local authority have been unable to obtain the land required in connection with the proposed drainage scheme, and they are now considering other schemes.
Stanford-le-Hope.	Sewage disposal works have recently been brought into operation, and premises are being connected with the works.
South Benfleet.	The local authority have not yet carried out works for the treatment of the drainage, which, however, is of small volume. They are being pressed to do so.

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6th October, 1903.

19184*. In this exceptionally able and clear minute that you have put before us you have told us what the constitution of your Board is, what the nature and scope of your powers are; you have described the processes by which you go to work, and it is really so clear that I do not see that I want to add to it, but there was one question that occurred to me that I should like to ask you, and that is in reference to the passage in which you say "Pollution has been diverted in 2,349 individual cases"?—That is the result since the passing of the Act of 1894.

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19185. Yes. You say, "Pollution has also been diverted in 2,349 individual cases." Well, now, what exactly do you mean by pollution being diverted?—That pollution has been kept out of the river and its tributaries.

19186. Can you give one an example; for instance, take a farm. We will say a farm is pretty near the river, and the drainage from the farm has hitherto been running into it?—Yes.

19187. Does it cease to run into the river, or is it treated in some way before it gets to the river?—When our inspector visits the place and finds there is such pollution as that he immediately reports the case to my office, and I write to the owner and occupier of the farm and ask for the pollution to be stopped, and they invariably take measures to stop it by some means or other. Of course we do not interfere with systems; we allow them to do as they like with regard to that, only satisfying ourselves afterwards that there is no pollution.

19188. Yes; but I mean the drainage has got to go somewhere. What I wanted to know was, do you mean that the drainage is purified before it gets into the river?—This is the chief Inspector (*Mr. Drummond*); you will excuse me asking him?

19189. Oh, certainly?—(*Mr. Drummond.*) In the case of a farm it is generally spread over the farm.

19190. (*Sir Michael Foster.*) The pollution you mean?—Yes.

19191. (*Chairman.*) And it does not go into the river at all?—No, unless the effluent is satisfactory.

19192. And the manufacturers now, what do they do with their trade refuse in cases where you say pollution is diverted?—They treat it by some means, filters and one thing and another.

19193. Filters?—Yes.

19194. Quite so; that is what I want to get at. Where sewage or trade refuse is filtered, would you call that a case where pollution has been diverted?—Yes, after treatment.

19195. You would?—(*Mr. Philipson.*) Yes; if the samples of effluent after treatment were satisfactory to the analyst, of course.

19196. But I think our experiments tend to show that filtration does not entirely get rid of pathogenic matter?—No.

19197. And, therefore, if you mean that pollution has been diverted by means of filtration the advantages you gain are not completely perfect?—What I mean to say is that the Conservators do not insist on any particular standard of purity, and the Act requires that no sewage or other offensive or injurious matter shall be passed into the streams, the Conservators leaving it to their chemist to state whether the samples sent to him for analysis are or are not sewage or other offensive or injurious matter. It does not mean that in all cases of diversion the discharge is absolutely got rid of, but it is so treated as to be brought within the requirements of the Thames Act.

19198. (*Sir Michael Foster.*) Is the decision left entirely to the chemist?—Entirely so.

19199. (*Chairman.*) There is no bacteriologist who is consulted?—No, simply a chemist.

19200. (*Sir Michael Foster.*) Dr. Groves is your chemist?—Yes.

19201. Are your examinations chemical only or bacteriological?—(*Mr. Groves*) Chemical only. I made some bacteriological observations some years ago, but it seemed to me perfectly futile. I mean, you get such an enormous number of bacteria that you could not possibly say whether there were any pathogenic bacteria present. Moreover, I may say that the purification which takes place takes place by means of bacteria, and, therefore, if the bacteria are of the sort that will destroy noxious

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matter, the more bacteria of that kind you have the better.

19202. (*Sir Wm. Ramsay.*) Are you speaking of the effluents ?—I am speaking of the effluents, but perhaps I might be allowed to say that as I wrote to the Commission when I was asked to give my opinion, I fully concur in the opinion of the Local Government Board that in the case of sewage farms no effluent should be allowed to run into the river unless it passes over land, because we have no instance, I believe, in which, where the effluent is passed over land, pathogenic bacteria can be detected in it.

19203. (*Chairman.*) I imagine that it is no part of your duty to consider the condition of the drinking-water ?—Of the drinking-water itself, no.

19204. No ?—It is only as to the purity of the water just above the intakes, as far as regards the chemical purity.

19205. (*Sir Michael Foster.*) It relates to the prevention of nuisances really ?—As far as chemical purity is concerned.

19206. With regard to your statement that after treatment by land there are no bacteria ?—No pathogenic bacteria. There is no evidence that pathogenic bacteria go through after land treatment as far as I know.

19207. Are you quite sure of that ? What is your authority for saying so ?—It is simply that I do not know of any such evidence.

19208. It is not your own experience. You are quoting some authority ?—I am quoting what I know about bacteria generally.

19209. What is the average number of pathogenic bacteria in effluents from sewage farms ?—I say I do not know that there are any. I do not, of course, count ordinary *coli* as pathogenic bacteria.

19210. Judgment as to whether the effluent should be diverted or not, I mean the decision as to whether it should be diverted or not is left to you, and also as to whether the treatment is effective ?—As to the chemical purity.

19211. But you have a standard, I suppose ?—Yes ; I have a standard. (*Mr. Philipson.*) The analyst has a standard.

19212. You have a standard which guides you in your decisions ?—(*Dr. Groves.*) Yes.

19213. I understand it is left to you to decide whether treatment is effective, and you have a standard for yourself ?—Yes.

19214. What is that standard ?—I gave it in the replies to the questions, that above the water intakes it ought always to be below ·2 parts per million.

19215. (*Colonel Harding.*) Would you repeat that ?—Below ·2 parts per million of albuminoid ammonia.

19216. Two parts per 100,000 gallons ?—No ; ·2 parts per 1,000,000. I might say that a considerable number of the sewage farms can manage to turn out ·1 per 1,000,000. That is ·01 per 100,000 ; that is the usual way of expressing it.

19217. (*Sir William Ramsay.*) Is any step taken with regard to towns such as Reading or Henley, or indeed any one of the larger towns on the Thames ? What becomes of the sewage ? Does it pass into the river ?—(*Mr. Philipson.*) You may take it as far as we know there is no crude sewage discharged into the Thames west of London now. All these places you have mentioned have been communicated with from time to time. Very large works have been carried out at Reading.

19218. You keep a look-out on them, I suppose ?—Yes, they are kept under regular inspection. I have got a list of all the sewage works in the watershed.

19219. (*Sir Michael Foster.*) And the effluent from all those has satisfied your Board ?—Speaking generally, yes. Samples of the effluents are taken every two months or oftener if necessary by the inspectors and sent to the analyst, who satisfies himself whether they are good, bad, or not bad, and if they are bad we communicate with the owners of the works.

19220. (*Sir William Ramsay.*) "Bad" means chemically bad. You do not trouble about whether bacteria are contained in the effluent or not ?—No.

19221. (*Sir Michael Foster.*) I think you said that you dealt simply with the nuisances ?—With offences against the Thames Act.

19222. But the object of your directions was to avoid all nuisances ?—The object is to secure discontinuance of pollution.

19223. You do not consider the water from the drinking point of view ?—Excepting under this one clause of our Act, which says this : "It shall be the duty of the Conservators by all lawful and proper means to preserve and maintain at all times, as far as may be, the flow and purity of the water of the Thames and its tributaries."

19224. But you have not interpreted "purity" as meaning drinking-water ?—Yes. The object of our Act, as stated in our preamble, was to so enlarge our powers as to enable us to preserve the river as a suitable source of domestic water supply for the metropolis and its suburbs, and our system is particularly designed and worked for this purpose.

19225. "Purity," so that it will appear pure to the senses ?—Yes, and satisfactory to the analyst.

19226. And not be considered a nuisance ?—Yes, and to comply with our requirements.

19227. (*Sir William Ramsay.*) I was going to ask you about vessels on the Thames above Teddington. How do you regard purity in the case of vessels if they discharge crude sewage into the river ?—We have power to board vessels and to require registration of steam launches and house boats. They do not discharge crude sewage.

19228. But what do they do with it ? I do not see what other course is open ?—There must not be a pipe into the water from these boats. They have earth closets.

19229. They have earth closets on the boats ?—Yes, they have earth or pail closets for the sewage, and receptacles for sink or lavatory discharges, and dispose of all refuse on land. Unless all pipes connecting with the river are cut off, the Conservators do not consider the arrangements satisfactory, and decline to register the vessels for use on the river.

19230. (*Colonel Harding.*) Where do they get rid of this matter ?—They put it on the land.

19231. On special plots ?—House boats are only allowed in certain parts of the river, and the owners of them make arrangements with the owners of adjacent land.

19232. (*Mr. Power.*) Speaking of scavenging, what do you do with the matter and refuse which is scavenged from the river ? Do you take it right away, or dispose of it within the precincts of the river ?—Bury it.

19233. And the dredgings, what do you do with these ?—The dredgings are taken to sea.

19234. Is it only the dredgings that you take down to Barrow Deep ?—That is all.

19235. None of the up-river scavenging matter ?—No.

19236. Is it a large bulk of the dredgings that you take down in the course of the year to Barrow Deep ?—Yes; last year we took about 400,000 tons.

19237. In the year ?—Yes.

19238. And that is done by day, I suppose, is it ?—Yes.

19239. How do you take that down ?—We take it down in steam hopper barges. As the dredger fills them they are taken away.

19240. And they discharge in Barrow Deep ? Have you particular regulations as to where they are to be taken to discharge ?—They must discharge within a certain radius the limits of which are defined by buoys, and the crew of the "Mouse" Lightship check these vessels as they go out and come back.

19241. Are their proceedings, broadly, similar to those of the London County Council ?—Identical.

19242. Identical ?—Yes ; the movements of the London County Council boats are similarly checked by the system which was inaugurated by the Conservators.

19243. (*Sir Michael Foster.*) I am not quite sure whether in your memorandum you stated what are the limits of your jurisdiction towards the mouth of the Thames ?—Yes ; Yantlet Creek.

19244. Then you have jurisdiction practically over

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the whole of the Thames Valley, the whole of the watershed, have you ?—Yes, practically.

19245. The whole of it above London ?—Yes. There are portions of certain counties within the watershed where we have no jurisdiction, and somewhat of an anomaly arises there because we may take proceeding against somebody for polluting the river in one county, whereas pollution of the same stream from places in another county cannot be dealt with by us.

19246. Then, what I was going to ask you was, considering yourself as an authority for preserving the purity of the Thames, do you consider that your powers are wholly adequate, and that the Acts give you everything that you desire, or has your experience led you to wish that certain amendments might be carried out ?—Yes ; I have made a representation to the Board on that particular subject ; there are certain things we should like to see carried out.

19247. Is that alluded to in your memorandum ?—It has not passed the Board yet, so that I cannot give evidence upon it. We have a very strong feeling that in certain cases our powers do want amending, but I would like the Inspector to point out on the plan.

(*A map was submitted to the Commissioners.*)

19248. This part of the Thames watershed (*indicating*) you have no jurisdiction over at all ?—(*Mr. Drummond.*) No, portions of Bedfordshire, Worcestershire, Sussex, Warwickshire, and Northamptonshire. That again (*indicating*) is in Northamptonshire. We have no jurisdiction over that. That again (*indicating*) is in Warwickshrie.

19249. Does that arise from your not representing the counties only ? (*Mr. Philipson.*) There are some portions of the counties of Warwick, Worcester, Bedford, Northampton, and Sussex in the Thames watershed, but in respect of which the Conservators' powers do not apply, their present jurisdiction being limited to certain counties named in Section 90 of the Thames Act.

19250. Does that arise from your not representing the area over which you have no jurisdiction ?—Yes. Forty-five places with a population of 27,500, and the total area is 158 miles, or 101,000 acres. (*Mr. Drummond.*) These (*indicating*) are detached portions of Worcestershire in our watershed but outside our jurisdiction, this at present being limited to the counties named in Section 90 of our Act of 1894. We have now a summons running against Moreton-in-the-Marsh, Gloucestershire. At the first hearing of the summons they pointed out to us that we were dealing with them, but not with the village of Evenlode, which is some few miles nearer the river. The difficulty which resulted in the Conservators not dealing with this was want of power, as Evenlode is a detached portion of Worcestershire, Worcestershire not being included in our Act. Then there (*indicating*) is another small portion, which we do not take, with a gas works. This (*indicating*) is the River Evenlode ; that (*indicating*) is the River Cherwell.

19251. Then, may I assume that is the great deficiency in your present Acts ?—(*Mr. Philipson.*) That is a deficiency I have pointed out, but I am not quite certain the Board will agree with me, because the question of representation will arise, and if we got our pollution powers extended to these counties they would naturally say, " We ought to have representation on your Board," and possibly we would not be prepared to concede that. It would mean five members if they got a member each. Besides, I am told by the Inspector there is not a great deal of pollution from these places. (*Mr. Drummond.*) There is not, Sir.

19252. (*Sir Michael Foster.*) Still, it is quite possible there might be a change. The population might be increased. There might be manufactories put up, and there might be a great deal of pollution. Would you not say from your experience that it is most desirable that the limits of an authority like yours should be determined by the natural features of the watershed without regard to county ?—Yes, I should say so. Then there is another point ; if you refer to Section 92 of our Act you will see that it limits us with regard to tributaries to three miles, for trade refuse. The Conservators consider the limit of three miles should be abolished.

19253. (*Colonel Harding.*) Three miles up the tributaries ?—Yes ; the reason of that is this. Take Wycombe Marsh Paper Mills ; that is five miles away. They use there a china clay which causes the discharge from this mill to seriously discolour the stream, making the water appear like milk, but the analyst cannot state that the discharge is offensive or injurious within the meaning of the Act, and the Conservators cannot deal with it as trade refuse, as it is beyond the three mile limit ; consequently the objectionable discharge continues. It might be more serious even than that ; therefore I think that the three mile limit ought to be excluded from the Act so far as it relates to the watershed above the metropolis. Then there is another point, and that is that our inspectors can only visit works—manufactories and sewage works and everything else—between the hours of nine in the morning and four in the afternoon. I think that in regard to sewage works and manufactories and works of any description they ought to have power to visit them at any time they like, because certain operations might be carried on, it is easily conceivable, after four o'clock in the afternoon and before nine o'clock in the morning.

19254. Then are there any other points as to which you would desire amendment ?—No, Sir, I do not think so.

19255. You have not considered at all the question of the Thames as a source of drinking water ?—No ; nothing further than what the Act says. Of course, that is our main object in keeping it pure.

19256. The standard of purity you have put before us is one which, as I have said, is determined by the senses and not by more exact examination ?—Not by the senses only, but by the exact chemical determination, as Mr. Groves will tell you, which shows whether anything is being discharged which would tend to unfit the water for purposes of domestic supply.

19257. You do not conceive that it was within your duty to take care that the water should be such as might be at all events in this or that place distributed for drinking purposes ?—I am afraid I cannot go beyond the powers in the Act ; but these are adequate to ensure freedom from contamination, and thus furnish a supply which, in conjunction with the ordinary filter-beds of the water companies, is perfectly satisfactory.

19258. (*Sir William Ramsay.*) Do not you wish an enlargement of the Act to give you those powers ? Is not that part of your scheme ?—That would mean a revolution of our whole system. I mean we could not carry out a scheme like that with our present staff, for instance.

19259. I do not know whether you know it has been already recommended that rivers boards should be created throughout the country, not of the kind you have advised, but boards which would keep the rivers in such a state of purity that the water can be used for drinking purposes if necessary. It would alter your rivers board in that case ; it would give you larger powers and, I suppose, give you larger revenue to draw upon. Would you be willing to undertake such a duty ?—I do not see any reason why we should not if we could get sufficient financial powers along with the other powers ; but at the present time we could not spend more than we are doing to secure the purity of the water supply.

19260. (*Sir Michael Foster.*) The income that you draw is only sufficient for this, if I may say so, more or less superficial examination of the water ?—Yes.

19261. As compared with the more or less exact examination which would be necessary if the water is to be largely used with absolute safety for drinking purposes ?—Of course, as a matter of fact, it is largely used now for drinking purposes.

19262. I know it is largely used for drinking, but you do not feel yourself responsible for insuring the absolute safety of that ?—Nothing further than the Act devolves that duty upon us. The Inspector (Mr. Drummond) suggests that I should put in Dr. Groves' statement with regard to the improvement in the quality of the water since 1894, when these powers came into operation.

19263. That might be put in. Could that be put in as evidence ? It is a quotation from Dr. Groves' report, is it ?—Yes.

19264. You put that in as evidence ?—This is Dr. Groves' own letter. Shall I read it, or would you like Dr. Groves to put it in. (*Dr. Groves.*) The letter is dated 1898, four years after the passing of the Act.

" Mr. Groves reported in May, 1898, as follows :—' Owing to the action taken by the Thames Conservancy

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under their Act of 1894, the amount of organic impurity observed in the water immediately above the intake, is now only about two-thirds of what it was before the passing of that Act.' "

19265. It is a brief statement of what had been effected between 1894 and 1898. I think the object will be effected if you will put that in as evidence. Have you any further improvement since 1898?—(*Dr. Groves.*) I might say that the general condition of the river has been very greatly improved since 1898, and more particularly in respect of the flood waters. As to the cause of this, I could not quite make that out when I gave evidence before the last Water Commission, and therefore I made practically no explanation; but it seems to me there is a very simple one. In places, for instance, like that where the Charterhouse School is, at Godalming, they used to pass the whole of their sewage direct into the Wey, and, of course, the sludge settled there, and the river was outside our jurisdiction, *i.e.*, before 1894. Then when the floods came the whole of this was washed down into the Thames. Now, of course, the sewage is all treated, and the effluent they send in is very good, so that it is practically clear water, and there is nothing for the water to carry away when you get a flood; consequently, the flood waters are very much purer than they used to be. That might possibly be of use to the Commission.

19266. (*Colonel Harding.*) You stated, I think, Mr. Philipson, that the amount of matter dredged up from the river is 400,000 tons a year, did not you?—Yes.

19267. Does that include the dredging in the docks?—No.

19268. Or is that carried on by the dock authorities?—It is carried on by the dock authority.

19269. And where is that taken to?—All the spoil removed from there is taken to the Barrow Deeps by the London and Tilbury Lighterage Company.

19270. Then passing on to the general question. You have more or less since 1857, have not you, been exercising the functions of a river board?—Yes, in a very incomplete sense only up to Staines until 1866.

19271. You have no power to make levies upon the authorities in your various areas to cover expenses?—No.

19272. Are you conversant with the general organisation of the Northern Rivers Boards in Lancashire and Yorkshire?—No.

19273. They are very important rivers boards?—I know of them; but I do not know their methods of working at all.

19274. But your duties are in effect similar to theirs; for example, you have to guard against the pollution of your large streams and rivers?—Yes, undoubtedly.

19275. Do you find then from the fact that you have been able to get local authorities to put down sewage works that, taking them generally, those sewage works are effective?—Yes, I should imagine so. The inspector suggests that they are generally effective.

19276. Then the standard, a personal standard I understood it to be, which your analytical chemist guides himself by is a standard for the effluents, is it not?—For the effluents.

19277. And you find that generally it will reach——? (*Dr. Groves.*) At the present time it is in very few cases that it does not come within this standard of ·02.

19278. In the Northern Rivers Boards dealing with rivers which are certainly in use for drinking purposes, they are using for practical purposes a standard which is by no means so exact as your own. It is a standard with regard to albuminoid ammonia of ·15 in 100,000. Yours is 100 times less?—Seventy-five times less.

19279. And you find that your effluents reach that standard?—Generally they reach that standard, or just a little above, but I have several sewage farms where the soil is good where it very seldom much exceeds ·01.

19280. Then perhaps Mr. Philipson could tell us out of the various methods of sewage treatment how many are by land filtration and how many are by so-called artificial filtration?—I am sorry I cannot tell you that.

19281. You have the information?—I have not got it here.

19282. Not in your office?—(*Mr. Drummond.*) We could get it. I have only with me here a list of the places where sewage works have been constructed.

19283. Then we may take it as your experience, speaking quite generally, that the methods of sewage treatment which you have induced local authorities to adopt have been found to be effective?—(*Mr. Philipson.*) Yes.

19284. But I suppose I may also take it that there are amongst them many that are dealing with their sewage by artificial filtration methods, and doubtless many others dealing with it by land filtration?—That is so.

19285. But either way you have been able to obtain sufficiently good results?—Yes.

19286. Now with regard to trade effluents there must be a course, over so large an area as you have to deal with, a considerable number of pollutions arising from manufactories?—Yes.

19287. What is your method of action with regard to these. I notice that you have in some directions very great powers, and that you have powers of inflicting very considerable fines. I noticed in glancing through your interesting statement that in some cases you can exact a fine of £100, and £50 a day during the time the pollution is continued?—Yes.

19288. But have you in regard to manufacturing or trade pollutions powers of dealing rapidly with any pollution that may arise?—Yes.

19289. Then what is the course you take?—Do you give notice to the manufacturer that he is polluting the stream?—Yes.

19290. Then within what time is he compelled to abate it?—Within three months, and if no improvement takes place we can bring him before a Court of Summary Jurisdiction immediately.

19291. Has he any appeal to the Local Government Board?—No, to the Board of Trade.

19292. To the Board of Trade?—Yes.

19293. He has power to appeal to the Board of Trade?—Yes.

19294. And does he in fact appeal to the Board of Trade?—I am afraid I have misled you; I was referring to pollution other than trade refuse. With regard to trade refuse we deal with them at once, and there is no appeal to the Board of Trade.

19295. What I was anxious to get at is this. We have some personal knowledge of the working of the northern rivers boards, and of the very great difficulty they have in reducing pollutions arising from trade sources. In their case they are obliged to give certain notices to the person who is causing the pollution before they can take any legal action against him, and they are obliged to summon him before their own body to show cause why action should not be taken. Then, before action can be taken, the permission of the Local Government Board has to be obtained, and that involves long delays, and finally, when the permission of the Local Government Board has been obtained, then an action can be begun against them. Do I understand that in your case you have none of these sources of delay, but are able to take immediate action?—We are able to take immediate action.

19296. Now, tell me, has that led to any serious injury to the extension of manufactories within your area. Has the fact that you have been able in this simple way to deal with trade pollutions caused much injury to the trade in your district?—Not to my knowledge. You have heard of none, have you, Mr. Drummond? (*Mr. Drummond.*) We act in a common sense point of view; we are not arbitrary.

19297. Then how do you deal with a new manufactory. Let us take the case of a man who is putting down the foundations of a mill or something of that kind. You notice this, you make inquiry, and you form the opinion that necessarily some effluent of a more or less unsatisfactory character will be delivered by that manufacturer into the stream. Do you then, during the course of erection, give notice to the manufacturer that he must purify or do you wait until the pollution arises?—(*Mr. Philipson.*) It is only when the pollution is an actual fact that we take any notice.

19298. Then you have no powers to give notice to the manufacturer that in putting down his manufactory he must at the same time provide any works that may be necessary for the purification of effluent ?—No, none at all.

19299. You wait until the pollution arises ?—Yes.

19300. Then what do you do ?—We have no alternative. We communicate with him as soon as pollution arises, and call attention to it.

19301. When you communicate with him what is the effect of the communication. Do you give him notice that he must within what time abate the nuisance ?—We send him a letter first, calling attention to the requirements of the Act, that he is committing an offence against the Act, and requiring him to discontinue it. In this letter we simply call attention to the pollution, and if there is nothing done in the space of two months, we give notice that we will take action against him.

19302. And you can take action ?—We can take action.

19303. Right away ?—There is nothing to prevent our taking action right away.

19304. I suppose you exercise reasonable indulgence if you find the manufacturer is seriously trying to abate the nuisance, but if he does nothing you take action ?—We do not harass people if we can possibly help it.

19305. Do you find within your area that local authorities are willing to receive trade effluents into their sewers ?—I could not answer that question of my own knowledge, but the inspector will be able to tell you.

19306. Can you answer that question ?—(*Mr. Drummond.*) In certain conditions where there are sewers we do not find the local authorities are adverse to it.

19307. But you have a great many cases where manufacturing pollutions go direct into the streams ?—Not untreated.

19308. Where they go to the streams eventually ?—Yes, treated though.

19309. But they do not by any means all of them connect up with sewers, though there are a great many so connected ?—In some cases the authorities will not have them at any price or under any conditions. The local authorities in a great many cases won't take them into their sewers.

19310. (*Sir Michael Foster.*) In the majority of cases ?—No; I could not say the majority. I could not exactly speak to that.

19311. About half ?—Perhaps.

19312. (*Colonel Harding.*) Which are those which they won't have at any price ?—Generally speaking the brewery refuse—there is an objection made to that.

19313. Any others ?—Generally speaking, I do not fancy that there is much objection to most of the other refuse, but anywhere where any lime process is in vogue, such as fellmongery or anything of that kind, that is an objection because of coating the sewer up.

19314. In those cases where they cannot connect with sewers you say they have been compelled by your Board to treat ?—Yes.

19315. They have successfully treated these various trade effluents ?—Yes, Sir, I think, taking all things into consideration and the volume of water, that these eventually get into, and even then, looking at the fact that it is used by London for drinking purposes, I think it is very satisfactory indeed.

19316. Then having heard just now how exacting the standard is which your Analytical Chemist keeps before him for passing these various effluents, are you able to suggest that these trade effluents reach anything like such a standard ?—Yes, I should say in most cases they do, they meet Mr. Groves' requirements. I know we are not satisfied until they do meet his requirements.

19317. Will you allow me to investigate that matter of the standard. Did I understand you to say that the standard by which you guide yourself in your decisions was one as to the presence of albuminoid ammonia and that the standard was ·002 ?—(*Dr. Groves.*) No; ·2 per 1,000,000; ·02 per 100,000.

19318. How many parts per 100,000 ?—·02.

19318.* Then I evidently misunderstood your previous answer if you say ·02 ?—·02 per 100,000.

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19319. (*Sir William Ramsay.*) I think Dr. Groves first said ·02 per million ?—That was a mistake.

19320. Then it is ·02 per 100,000 ?—Yes, that is right.

19321. (*Colonel Harding.*) If I recollect right, the Northern Rivers Board is ·01 per gallon, which would be about ·15 per 100,000, so it is really only seven times more stringent. In your previous answer I think you said 75; I was possibly myself to blame for that. However, it is as well to have that cleared up. May I also ask of you the question which I asked of your inspector just now, as to whether in judging of the purification of trade effluents you use a similar standard ?—A similar standard, yes.

19322. And you really find you can get brewery refuse and other trade effluents purified to pass that standard ?—No; that standard is the standard for a *good* effluent, but it is not the standard which is passed. It would take ten times as much.

19323. (*Sir William Ramsay.*) You allow to pass ·2 ?—I allow to pass ·2 per 100,000.

19324. (*Sir Michael Foster.*) May I ask what is the lowest you pass ?—·2 in the upper reaches of the river (*Mr. Philipson.*) May I explain that we divide the river into three different portions, the upper, the middle, and the lower. (*Dr. Groves.*) Above the intakes we have a much higher standard. (*Mr. Philipson.*) It is shown, Sir, on the table.

19325. (*Colonel Harding.*) Do you test your samples by the albuminoid ammonia ?—Yes, by the albuminoid ammonia method. As I stated in the answer to the questions which were asked me about this, I find in regard to the oxygen absorbed, which is a very good indication of the purity of waters, that it is of very little use for effluents, because in many cases sewage effluents, particularly if a sewage farm is working well, may contain nitrates. I may say also that in the case of paper mills I have found in many instances, I do not know why, a considerable quantity of nitrites. Of course, in a sewage farm that shows that the sewage farm is working well, that the decomposable matter is being got rid of, but it would make, of course (as this nitrite absorbs oxygen in order to convert it into nitrate), a good effluent—what may be a very good effluent—appear as a bad one, so that although I always do the "oxygen absorbed" as a check and for general information, I report practically upon the amount of albuminoid ammonia.

19326. In the presence of nitrates and nitrites you allow a larger proportion of organic matter ?—No.

19327. Do not you ?—No; the albuminoid ammonia represents as fairly as anything can do the amount of easily decomposable nitrogenous matter which is present, putrescible nitrogenous matter.

19328. Then I think we did not quite get to the point which Sir Michael Foster was also anxious to get, and that is, what is the worst standard ? The worst standard which enables you to pass anything really is not the standard of what you consider to be a good effluent, but a standard which enables you to say this may just pass in regard to trade effluents ?—Just so. Two parts per million.

19329. In regard to other effluents also ?—Yes.

19330. And your experience also in this district is that you find that brewers can purify these effluents from breweries and that effluents from other trade sources to that standard ?—Yes, they do.

19331. Do you find some cases where they have a difficulty in getting it ?—Well, there was one case where they had a difficulty, but they managed to run the effluent into the sewer.

19332. Then, of course, they did not deal with it ?—They did not deal with it.

19333. (*Sir Michael Foster.*) When you say two you mean two per million ?—Yes.

19334. ·2 per 100,000 ?—·2 per 100,000; two parts per 1,000,000. There is a little difficulty perhaps arises here. A good effluent is ·2 parts per 1,000,000; but anything which is ten times as bad at that I reject and say that that is a bad effluent, and I do not allow it to pass.

19335. (*Colonel Harding.*) Then it may pass a standard

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of two per 1,000,000. It must be less than a standard of two per 1,000,000 ?—Less than two per 1,000,000.

19336. That is an effluent to pass with approval, not necessarily high approval, but to be allowed to pass into the river ?—I always call attention to the fact that it is on the limit. I can only just pass it.

19337. You have in your office, Mr. Philipson, records of the various methods which are employed in purifying trade effluents and of the success which each of them reaches ?—(*Mr. Philipson.*) No.

19338. Your inspector has this information, surely ?—(*Mr. Drummond.*) Not the detailed information, Sir. I have the knowledge, you see, up to a certain point.

19339. But, having that knowledge, do not you tabulate it and fix it in the information for your Board ?—Well, you see, the whole process does not go through me. I do not give the analysts' report direct, so, whatever my opinion might be on the matter, it would really not be scientific. (*Mr. Philipson.*) It is beyond the scope of our powers.

19340. (*Sir William Ramsay.*) I would like to put to Mr. Groves this question : does he ever get an effluent or anything on land after very long filtration which contains ·02 of albuminoid ammonia per 100,000 ? Has it ever been known ? (*Mr. Groves.*) That I cannot say, absolutely. A large number of the trade effluents that we have are from paper mills.

19341. I am not speaking of other effluents, I am speaking of sewage effluents here. Has it ever been found that any sewage effluent whatever has reached a purity of ·02 per cent. per 100,000 ?—That I cannot say, because they have all to pass through land in sewage farms.

19342. From Reading, for instance, has the whole of the sewage to pass over land ?—Yes, Sir, it has.

19342*. At Oxford it has ?—Yes.

19343. (*Colonel Harding.*) What about Staines ? Is that passed over land ?—(*Mr. Drummond.*) The Staines sewage passes through bacteria beds and gets into the Ash stream through the effluent drain, nearly two miles long. The Ash stream comes into the river at Sunbury after running over five miles from the effluent drain to the Thames.

19344. (*Sir William Ramsay.*) Is this final effluent you are speaking of that comes into the river the effluent as it comes out of the sewage works ?—(*Mr. Groves.*) No, as it comes out of the sewage treatment works.

19345. That is the exact point I want to call attention to. If you take the effluent from the sewage works you cannot possibly put a standard of ·02 upon it ?—I think it is doubtful.

19346. I mean it is ten times better than anybody else can obtain ?—Yes.

19347. Then we do right to understand that you sometimes take effluent from the sewage works, but generally it runs overland ?—As far as I can remember, they run over land from the sewage works.

19348. Is there any case in which effluents are taken direct into the Thames from sewage works treatment without passing over land ?—(*Mr. Drummond.*) Yes, at Kingston. (*Dr. Groves.*) That is below the intakes ; I am speaking entirely of the river above the intakes.

19349. There is no case above the intakes in which the effluent does not pass over land ?—The inspector could give you any. He has local knowledge of all the farms on the Thames. It is so, is it not, that there is no sewage farm effluent that passes direct into the river above the intakes. ? (*Mr. Drummond.*) No, either land, or artificial treatment.

19350. That is the very thing we want to get at.—Land or artificial treatment.

19351. (*Sir Michael Foster.*) Does the effluent which is the subject of artificial treatment go direct into the river above the water intakes ?—I should say yes.

19352. (*Sir William Ramsay.*) I want to put to Mr. Groves this question : when it does go in, have you ever found that the albuminoid ammonia is as low as ·02 ?—(*Dr. Groves.*) I cannot give you that information now. I could give you the information. (*Mr. Drummond.*) You are putting Mr. Groves rather at a disadvantage, because it is the inspector who takes the sample ; he analyses them afterwards, so that really he knows nothing about the locality of these farms really ; it is better that he should not. (*Dr. Groves.*) If you would like the information I can supply it.

19353. I think we should. Do not you think, Colonel Harding, that we should know how much unpurified effluent goes into the river ?

19354. (*Colonel Harding.*) I think it is very important that point should be cleared. ·2 per 1,000,000 is a standard of perfection which is not reached. (*Dr. Groves.*) This is what I call a good one, but it is frequently reached, and there are several cases which it is only half that. [*See Appendix A at end of Mr. Groves' evidence.*]

19355. In the case of trade effluents, at all events, you are satisfied with one ten times more lenient ?—I pass it. (*Mr. Philipson.*) If there is any information you want upon this particular point I will see what I can do to get it.

19356. (*The Secretary.*) There might be a table put in at the end of the evidence when the proof comes back giving some typical effluents from land and from artificial sources.

(*Sir Michael Foster.*) Above the intakes ?

(*Mr. Philipson.*) All above the intakes. We can get that out. [*See Appendix B to Mr. Philipson's Evidence.*]

19357. (*Sir William Ramsay.*) We should like to know in how many places effluent is discharged from sewage works direct into the river without land.—(*Mr. Drummond.*) Of course that would include tributaries as well (*Mr. Philipson.*) In the watershed above London ; that is what I understand. (*Dr. Groves.*) You do not mean individual houses ?

19358. Oh, no. Where there are sewage works. (*Dr. Groves.*) And, Mr. Drummond, if you will just say what the distance is from the Thames it would be useful.

19359. That will be worth having.—(*Mr. Philipson.*) With regard to those points that my attention was directed to when the Lord Chairman was out of the room, I can state that they at the present time form the subject of consideration by the conservators, and in one or two instances I quite expect they will be agreed to. What I propose to do, if you wish it, is to come before you again with any proposals that they may assent to.

(*Sir Michael Foster.*) I think if you will write to Mr. Willis, stating what has been the decision of your Board with regard to the actual watershed, that will do.

(*The representatives of the Thames Conservancy then withdrew.*)

APPENDIX A TO MR. GROVES' EVIDENCE.

Laboratory of the Thames Conservancy,
352, Kennington Road, S.E.,
17th November, 1903.

SIR,

I now send the Supplementary Statement, alluded to in your letter of the 13th inst., as an appendix to my evidence.

I should like to see a proof at your convenience in order that I may check the figures in the tables.

I am, Sir, yours truly,
CHARLES E. GROVES.

The Secretary,
Royal Commission on Sewage Disposal.

SUPPLEMENTARY STATEMENT, being Appendix A, to the evidence given by Mr. C. E. GROVES, Chemist of the Thames Conservancy.

Standard of purity of effluents passing into the Thames and its tributaries above the intakes of the Water Companies.

A *good* effluent is one which does not give more than 0·02 per 100,000 (0·2 per million) of albuminoid ammonia. An effluent which gives more than 0·2 per 100,000 (2·0 per million) is a *bad* effluent. In all cases where it is 0·2 per 100,000 it is reported as being " on the limit."

In the accompanying tables are given the results of the examination of the effluents from the more important towns and villages taken, during the years 1902 and 1903 (to end of October, 1903), at the point where the treated sewage passes into the Thames or one of its "tributaries."

TABLE I. gives 21 towns where the albuminoid ammonia in the samples has not exceeded 0·1 per 100,000.

TABLE II. gives 15 towns where the albuminoid ammonia in some of the samples has exceeded 0·1 per 100,000, as will be seen from an inspection of the table. The cases—called "abnormal"—where it has exceeded this limit are few as compared with those where it is "normal" (*i.e.*, 0·1 per 100,000 or less), except at Hartley Wintney, Sandhurst, Wokingham, and St. Albans.

TABLE III. (Septic Treatment). It may be of interest to the members of the Commission to have special data of places where "septic" treatment is in operation amongst the sewage works connecting with the Thames either directly or indirectly. The table gives for seven such places :—

(*a*) The system employed.

(*b*) Population per acre of land used for tretament of the sewage.

(*c*) Parts per 100,000 of albuminoid ammonia (average of all the samples taken).

N.B.—Land treatment is employed at all the places mentioned in these three tables.

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TABLE I.

Place.	Number of sample.	Parts of Albumenoid Ammonia per 100,000			Remarks.
		Highest.	Lowest.	Average.	
Abingdon	10	0·03	0·02	0·021	
Bourton-on-Water	11	0·05	0·005	0·020	
Chipping Norton	8	0·06	0·016	0·030	
Cirencester	10	0·03	0·005	0·012	
Chesham	9	0-04	0·015	0·030	
Faringdon	11	0·03	0·010	0·012	
Fairford	12	0·04	0·005	0·014	
Farnham	11	0·07	0·03	0·044	
Highworth { Eastrop Westrop }	10	0·04	0·01	0·024	
Maidenhead	21	0·1	0·04	0·07	
Odiham	8	0·05	0·03	0·034	
Staines (Stanwell)	11	0·1	0·02	0·035	
Tring	9	0·03	0·005	0·014	
Uxbridge	10	0·1	0·04	0·066	
Wycombe	22	0·07	0·02	0·036	
Weybridge	11	0·06	0·03	0·035	
Woking	11	0·06	0·05	0·054	
West Drayton	9	0·06	0·02	0·034	
Wellington College	10	0·04	0·015	0·028	
Wroughton	10	0·08	0·008	0·045	
Yiewsley	10	0·04	0·01	0·029	

In Table I., where in no instance has the amount of albuminoid ammonia exceeded 0·1 per 100,000, it will be seen there are six places where the average is only 0·02 per 100,000, namely, Abingdon, Bourton-on-the-Water, Cirencester, Faringdon, Fairford and Tring; whilst sometimes the albuminoid ammonia in individual samples sinks as low as 0·01 and even 0·005 per 100,000.

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TABLE II.

Place.		Number of Sample.	Parts of Albumenoid Ammonia per 100,000		
			Highest.	Lowest.	Average.
Ardington	*Normal	9	0·1	0·02	0·05
	*Abnormal	2	0·2	0·11	0·16
Bicester	Normal	10	0·08	0·03	0·04
	Abnormal	1	0·15		
Boreham Wood	Normal	11	0·1	0·05	0·08
	Abnormal	1	0·15		
Cranley	Normal	8	0·08	0·015	0·037
	Abnormal	1	0·		
Trimley Street	Normal	9	0·1	0·03	0·062
	Abnormal	2	0·15	0·12	0·135
Godalming	Normal	10	0·08	0·04	0·052
	Abnormal	1	0·14		
Guildford	Normal	9	0·08	0·05	0·065
	Abnormal	1	0·25		
Hartley Wintney	Normal	7	0·1	0·05	0·08
	Abnormal	4	0·3	0·15	0·2
Newbury	Normal	9	0·08	0·05	0·06
	Abnormal	2	0·16	0·15	0·155
Oxford	Normal	25	0·1	0·02	0·046
	Abnormal	8	0·25	0·12	0·15
Reading	Normal	42	0·10	0·016	0·053
	Abnormal	2	0·16	0·12	0·14
Sandhurst	Normal	4	0·10	0·05	0·08
	Abnormal	3	0·16	0·15	0·153
Swindon	Normal	33	0·10	0·02	0·055
	Abnormal	4	0·3	0·15	0·2
Wokingham	Normal	24	0·1	0·05	0·07
	Abnormal	15	0·35	0·12	0·21
St. Albans	Normal	6	0·10	0·06	0·08
	Abnormal	5	0·20	0·14	0·17

* Normal = 0·10 per 100,000 and less. Abnormal = over 0·1 per 100,000.

In Table II., the average for the "normal" samples is, in most cases, considerably higher than in Table I., but with three exceptions, the average of the "abnormal" samples is below 0·2 per 100,000

TABLE III.

Place.	System.	Albumenoid Ammonia per 100,000.	Remarks.	Population per acre.
Chipping Norton	Septic ; filtration ; irrigation	0·03	Good	540
Fairford	Septic ; irrigation	0·014	Good	468
Wellington College	Septic ; irrigation	0·028	Good	War Dept.
Berkhamsted	Septic ; contact ; land filtration	0·095	Fair	467
Didcot	Septic ; irrigation	0·14	Bad	46
Farnborough	Septic ; contact ; irrigation	0·14	Bad	766
Hartney Wintney	Septic, contact ; land filtration and irrigation	0·125	Bad	336

There are nine places above the intakes where septic tanks are used, but as we have had but few samples taken at Wantage and Bramley, these two are omitted, and the results from the remaining seven only are given in the above table ; of these, it will be seen three are good and three bad.

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APPENDIX B. to Mr. Philipson's Evidence.

THAMES CONSERVANCY.

A LIST of Places in the Thames Watershed where Sewage Works are in operation, with particulars as to Method of Treatment, &c.

Also a List of Manufacturing Premises (Mills, Breweries, Gas Works, &c.) and Isolated Premises, where Purification Works have been carried out.

A.—Sewage Works where the effluent is eventually passed over land before being discharged into the River.
B.—Sewage Works where no land treatment is provided.
C.—Sewage Works where there is no effluent to any stream.
D.—Manufacturing Premises (Mills, Breweries, &c.) and Isolated Premises.
E.—Gas Works.

N.B.—All the places named are above the Intakes of the London Water Companies.

LIST A.

Name of Place.	Population, 1901.	County.	Nature of Works.	Method of Treatment.	Extent of Land in Acres.	If any Effluent.	In the Watershed of	Miles along Streams to Thames.
Bourton-on-the-Water	1,097	Gloucester	Sewage Farm	Precipitation and irrigation	15	Yes	Windrush	24
Chipping Norton	3,780	Oxon	Sewage Works	Septic tanks, filtration and irrigation	7	,,	Evenlode	27
Cricklade	1,517	Wilts.	Sewage Farm	Irrigation only	7	,,	Thames	—
Cirencester	7,536	Gloucester	Sewage Farm	Precipitation, filtration and irrigation	87	,,	Churn	3
Faringdon	2,900	Berks.	Sewage Farm	Filtration and irrigation	250	,,	Brook	4
Fairford	1,404	Gloucester	Sewage Farm	Septic tank and irrigation	3	,,	Coln	4
Highworth:								
Eastropp	2,205	Wilts.	Sewage Farm	Precipitation and filtration	14	,,	Cole	5½
Westropp					20	,,	Byde Mill Brook	5
Old Swindon	45,006	Wilts.	Sewage Farm	Precipitation, contact beds and land filtration	140	,,	Ray	10
New Swindon					120	,,	Ray	8

Wroughton	2,448	Wilts.	Sewage Farm	Precipitation and irrigation	4	Yes	Ray	12
Oxford	49,336	Oxon	Sewage Farm	Broad irrigation and land filtration	995	,,	Minchery Brook	2½
Abingdon	6,480	Berks.	Sewage Farm	Broad irrigation and land filtration	32	,,	Thames	Bank of.
Banbury	12,968	Oxon	Sewage Farm	Broad irrigation	240	,,	Cherwell	31½
Bicester	3,023	Oxon	Sewage Farm	Sedimentation and irrigation	26	,,	Cherwell	15
Wantage	3,766	Berks.	Sewage Works	Septic tanks, filtration and irrigation	3½	,,	Ock	9½
Upper Slaughter	239	Gloucester	Sewage Farm	Sedimentation and irrigation	2	,,	Windrush	28
Didcot	420	Berks.	Sewage Farm	Septic tanks and irrigation	9	,,	Moor Ditch	3
Ardington	479	Berks.	Sewage Farm	Sedimentation and irrigation	5	,,	Mill Brook	6½
Aylesbury	9,243	Bucks.	Sewage Works	Precipitation, contact beds and irrigation	14	,,	Thame	29
Bracknell	In East-hampstead.	Berks.	Sewage Farm	Contact beds and land filtration	10	,,	The Cut	9½
Kingston Blount	With Aston Rowant.	Oxon	Sewage Field	Broad irrigation	10	,,	Thame	24
Maidenhead	12,980	Berks.	Sewage Works	Precipitation, contact beds and land filtration	20	,,	The Cut	2¼
Princes Risborough	2,189	Bucks.	Sewage Farm	Filtration and irrigation	3	,,	Thame	27
Stewkley	1,159	Bucks.	Sewage Farm	Sedimentation, contact beds and irrigation	5	,,	Thame	36
Tring	4,349	Herts.	Sewage Field	Broad irrigation	20	,,	Thame	41
Wycombe	15,542	Bucks.	Sewage Farm	Precipitation and land filtration	9½	,,	Wye	8¼
Reading	72,217	Berks.	Sewage Farm	Broad irrigation and land filtration	850	,,	Kennet	2¾
Wokingham:								
Bucks Copse	3,551	Berks.	Sewage Farm	Contact beds and broad irrigation	4	,,	Loddon	10½
Union				Sedimentation, land filtration and irrigation	1	,,	Loddon	10
Ashridge				Sedimentation, land filtration and irrigation	7	,,	Loddon	8½
Sandhurst (Royal Military College)	—	Berks.	Sewage Farm	Irrigation and land filtration	13	,,	Loddon	20
Wellington College	In Crowthorne.	Berks.	Sewage Farm	Septic tank and irrigation	22	,,	Loddon	22
Stratton St. Margaret	3,232	Wilts.	Sewage Field	Broad irrigation	7	,,	Cole	9

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APPENDIX B. to Mr. Philipson's Evidence.—THAMES CONSERVANCY.—LIST A.—*continued*

Name of Place.	Population, 1901.	County.	Nature of Works.	Method of Treatment.	Extent of Land in Acres.	If any Effluent.	In the Watershed of	Mile along Streams to Thames.
Aldershot Camps	30,974	Hants.	Sewage Farm	Sedimentation and irrigation	131	Y	Loddon	28
Aldershot Town				Sedimentation, contact beds and irrigation	35	,,	Loddon	30
Farnborough	11,500	Hants.	Sewage Farm	Septic tanks, contact beds and irrigation	15	,,	Loddon	24
Hartley Wintney	2,019	Hants.	Sewage Farm	Septic tanks, contact beds, land filtration and irrigation	6	,,	Loddon	16
Odiham	2,699	Hants.	Sewage Fields	Sedimentation and irrigation	75	,,	Loddon	21
Camberley	8,409	Surrey	Sewage Farm	Sedimentation and irrigation	35	,,	Loddon	20
Frimley Street			Sewage Farm	Sedimentation and irrigation	2	,,	Loddon	22
St. Albans	16,019	Herts.	Sewage Farm	Contact beds and land filtration	30	,,	Colne	26
Bushey	2,122	Herts.	Sewage Farm	Precipitation and irrigation	14	,,	Colne	16¼
Chesham	7,245	Bucks.	Sewage Farm	Sedimentation and irrigation	8	,,	Colne	23
Uxbridge	3,063	Middlesex	Sewage Works	Sedimentation sprinkler, filters and land filtration	5	,,	Colne	8
Yiewsley, Cowley, Hillingdon and West Drayton.	13,661	Middlesex	Sewage Works	Contact beds and land filtration	11	,,	Colne	6
Boreham Wood	With Elstree.	Herts.	Sewage Farm	Ballast filtration and irrigation	6	,,	Colne	27
Potters Bar	In South Mimms.	Middlesex	Sewage Farm	Precipitation, filtration and irrigation	20	,,	Colne	31
Berkhampstead	5,140	Herts.	Sewage Farm	Septic tank, contact beds and land filtration	11	,,	Colne	29
Farnham	6,124	Surrey	Sewage Farm	Precipitation and land filtration	13	,,	Wey	29
Guildford	15,938	Surrey	Sewage Works	Precipitation, contact beds and land filtration	17	,,	Wey	14
Godalming	8,748	Surrey	Sewage Works	Sedimentation and land filtration	84	,,	Wey	19
Weybridge	5,329	Surrey	Sewage Works	Precipitation and land filtration	27	,,	Wey	3
Cranley	2,709	Surrey	Sewage Works	Sedimentation, contact beds and land filtration	21	,,	Wey	22
Stoke	4,462	Surrey	Sewage Farm	Contact beds and land filtration	17	,,	Wey	14

Woking	**16,244**	**Surrey**	**Sewage Farm**	**Upward and land filtration**	43	Yes	Wey	9
Bramley	1,915	Surrey	Sewage Works	Septic tanks, contact beds and land filtration	2	,,	Wey	18½
Homewood	In Ripley.	Surrey	Sewage Farm	Sedimentation and irrigation	2	,,	Wey	7
Ripley Green	In Ripley.	Surrey	Sewage Farm	Sedimentation and irrigation	1½	,,	Wey	7
Staines	2,210	Middlesex	Sewage Works	Precipitation, contact beds and land filtration	29	,,	Ash	5½
Steeple Aston	619	Oxon.	Sewage Farm	Sedimentation and irrigation	1	,,	Cherwell	19½
East Hendred	748	Berks.	Sewage Farm	Sedimentation and land filtration and irrigation	1½	,,	Ock	6
Newbury	11,061	Berks.	Sewage Farm	Contact beds, irrigation and land filtration	14	,,	Kennet	20
Ruislip	3,56	Middlesex	Sewage Works	Double contact beds and land filtration	5	,,	Colne	11
Kingsclere	2,452	Hants.	Sewage Farm	Tanks and irrigation	4½	,,	Kennet	20
Deep Cut Barracks, Frimley	—	Surrey	Sewage Farm	Septic tanks, contact beds and irrigation	7	,,	Wey	15
Ewshott Barracks, Crondall	—	Hants.	Sewage Farm	Broad irrigation	8	,,	Loddon	25

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Appendix B. to Mr. Philipson's Evidence.—Thames Conservancy—*continued.*

LIST B.

Name of Place.	Population 1901.	County.	Nature of Works.	Remarks, How treated, &c.	If any effluent.	In the Water shed of	Miles along streams to Thames.
Ashbury	589	Berks	Tank	At the end of a surface drain	Yes	Cole	11½
Aston	647	Oxon	Filter	(Gravel) at the end of a surface drain	,,	Great Brook	2½
Charlbury	1,352	Oxon	Tanks	At the end of a surface drain	,,	Evenlode	14
Cricklade (Feoffees Drain)	See List A	Wilts.	Tank and filter	At the end of a surface drain	,,	Key	1
Fairford (Milton End)	See List A	Gloucester	Tank and filter	At the end of a surface drain	,,	Coln	4
Stratton	836	Gloucester	Tank and filter	(Coke) at the end of a surface drain	,,	Churn	7
Poulton	376	Gloucester	Tank and filter	(Coke) at the end of a surface drain	,,	Ampney Brook	5
Haydon Wick	In Redbourn	Wilts	Filters	(Coke) at the end of a surface drain	,,	Ray	5½
Lechlade	1,179	Gloucester	Filter	(Coke) at the end of a surface drain	,,	Thames	—
Stanford-in-the-Vale	728	Berks.	Tank and filter	(Gravel) at the end of a surface drain	,,	Ock	10½
Deddington	1,490	Oxon.	Tank and filter	(Gravel) at the end of a surface drain	,,	Cherwell	25
Cropredy	436	Oxon.	Tank	At the end of a surface drain	,,	Cherwell	36½
Hanwell	176	Oxon.	Tank	Treats the whole flow in the watercourse	,,	Cherwell	34
Childrey	489	Berks.	Tank and filters	(Coke): treat the whole flow in the watercourse	,,	Ock	11
Harwell	648	Berks.	Filter	(Ash)	,,	Moor Ditch	4½
Launton	545	Oxon.	Tanks and filters	Chemicals; filter at the end of a surface drain	,,	Cherwell	22
Edgcott	136	Bucks.	Tank	At the end of a surface drain	,,	Cherwell	28
Upper Heyford	319	Oxon.	Tank and filters	Chemicals	,,	Oxford Canal	20
East Challow	506	Berks	Tank and filter	Treat the whole flow in the watercourse	,,	Ock	9½
March Gibbon	598	Bucks	Tanks	Treat the whole flow in the watercourse	,,	Cherwell	21
Wendlebury	196	Oxon.	Tanks	At the end of a surface drain	,,	Cherwell	13
Bierton	683	Bucks.	Tank and filter	A series of coke filters	,,	Thame	28
Cheddington	578	Bucks	Tank and filter	(Coke) and contact beds	,,	Thame	37½
Tetsworth	382	Oxon.	Filter	(Gravel and coke) at the end of a surface drain	,,	Thame	13½
Little Haseley Great Haseley	551	Oxon.	Filter	(Gravel and coke) at the end of a surface drain	,,	Thame	9½ 8
Cuddington	445	Bucks.	Filter	(Small, continuous flow) at the end of a surface drain	,,	Thame	23½
Dinton	663	Bucks	Filter	(Small, continuous flow) at the end of a surface drain	,,	Thame	24½
Sydenham	362	Oxon.	Filter	Upward and downward filtration	,,	Thame	23
Weedon	325	Bucks.	Filters	(Coke and ballast) at the end of a surface drain	,,	Thame	37
Farnborough Street	In Farnborough	Hants.	Pit and filter	(Gravel)) at the end of a surface drain	,,	Loddon	25
Hook Norton	1,386	Oxon.	Tanks and filters	(Gravel) at the end of a surface drain	,,	Cherwell	37
Letchmore Heat	With Aldenham	Herts.	Filters	(Gravel)	,,	Colne	20

APPENDIX B. to Mr. Philipson's Evidence.—THAMES CONSERVANCY—*continued.*

LIST C.

Name of Place.	Population, 1901.	County.	Nature of Works.	Method of Treatment.	Extent of Land in Acres.	In the Watershed of	Miles along streams to Thames.	Remarks.
Witney	3,574	Oxon.	Sewage Works	Double contact beds and irrigation	7	Windrush	7	Soaks away.
London Colney	In Ridge and Shenley.	Herts.	" "	Tank and irrigation	½	Colne	24	" "
South Mimms	2,671	Middlesex and Herts.	" "	Tank and irrigation	6	Colne	34	" "
Alton	5,479	Hants.	" "	Contact beds and irrigation	10	Wey	38	" "
Hemel Hempstead	11,264	Herts.	" "	Precipitation	57½	Colne	26	" "
Redbourn	1,932	Herts.	" "	Tank and contact bed	—	Colne	30	" "
Thame	2,911	Oxon.	" "	Filtration and irrigation	13	Thame	19	" "
Eynsham	1,757	Oxon.	" "	Candy's tank and irrigation	5	Thames	1	" "
Watford	27,205	Herts.	" "	Contact beds and irrigation	283	Colne	17	" "
Wallingford	2,808	Berks.	" "	Sedimentation and irrigation	10	Mill Brook	1	" "
Caversham	6,580	Oxon.	" "	Contact beds and irrigation	9	Thames	—	" "
Islip	554	Oxon.	" "	Tanks	—	Cherwell	7	" "
Bodicote	689	Oxon.	" "	Tanks and irrigation	3	Cherwell	29½	" "
Stratton Audley	336	Oxon.	" "	Sub-irrigation	—	Cherwell	19	" "
Wendover	2,009	Bucks.	" "	Upward filtration and irrigation	5	Thame	36	" "
Thatcham	2,177	Berks.	" "	Small tanks and irrigation	4	Kennet	16	" "
Wardington	569	Oxon.	" "	Sub-irrigation	¼	Cherwell	38	" "
Woolhampton	472	Berks.	" "	Sub-irrigation	¼	Kennet	12	" "
Windsor	14,130	Berks.	" "	Irrigation	50	Thames	—	" "
Windsor Castle			" "	Irrigation	20	Thames	—	" "

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APPENDIX B to Mr. Philipson's Evidence.—THAMES CONSERVANCY.—LIST C.—*continued.*

Name of Place.	Population 1901.	County.	Nature of Works.	Method of Treatment.	Extent of land in acres.	In the Watershed of	Miles along stream to Thames.	Remarks.
Sunbury	4,544	Middlesex	Sewage Works	Irrigation	15	Thames	—	Soaks away.
Sonning	442	Berks.	,, ,,	Contact beds and irrigation	20	Thames	—	,, ,,
Little Milton	311	Oxon.	,, ,,	Irrigation	5	Thame	8	,, ,,
Blackthorn	260	Oxon.	,, ,,	Tank and filtration	—	Cherwell	14½	,, ,,
Aldermaston	482	Berks.	,, ,	Gravel pit filtration	2	Kennet	12	,, ,,
Radlett	In Aldenham.	Herts.	,, ,,	Septic tank contact beds and irrigation	8	Colne	24	,, ,,
Rodbourn Cheney	1,004	Wilts.	,, ,,	Sedimentation and irrigation	2	Ray	6	,, ,,
Slough	11,543	Bucks.	,, ,,	Irrigation	25	Thames	—	,, ,,
Eton	3,301	Bucks.	,, ,,	Irrigation	42	Thames	—	,, ,,
Beaconsfield	1,570	Bucks.	,, ,,	Irrigation	10	Wye	5	,, ,,
Stanton Fitzwarren	166	Wilts.	,, ,,	Irrigation	—	Byde Mill Brook.	5½	,, ,,
Hannington	220	Wilts.	,, ,,	Irrigation	—	Byde Mill Brook.	3½	,, ,,
Woodstock	1,684	Oxon.	,, ,,	All drainage sinks into fissures	—	Evenlode	5½	,, ,,
Great Bourton	426	Oxon.	,, ,,	Tanks		Cherwell	37	,, ,,
Bloxham	1,340	Oxon.	,, ,,	Sedimentation and irrigation	3	Cherwell	30	,, ,,
Clifton Hampden	290	Oxon.	,, ,,	Irrigation	—	Thames	—	,, ,,
Middleton Stoney	324	Oxon.	,, ,,	Tanks	—	Cherwell	15	,, ,,
Brill	1,206	Bucks.	,, ,,	Irrigation	2	Thame	18	,, ,,
Dorchester	808	Oxon.	,, ,,	Tank and irrigation	1½	Thame	1	,, ,,
Haddenham	1,223	Bucks.	,, ,,	Large pits emptied and contents disposed of by the Local Authority.	—	Thame	23	,, ,,
Henley	5,984	Oxon.	,, ,,	Reeves process and irrigation	8½	Thames	2	,, ,,

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Shabbington	254	Bucks.	Sewage Works	Tanks and irrigation	3	Thames	17	Soaks away.
Wheatley	872	Oxon.	,, ,,	Irrigation	5	Thames	11½	,, ,,
Monks Risborough	714	Bucks.	,, ,,	Tank emptied and contents disposed of by the Local Authority.	—	Thames	28	,, ,,
Long Crendon	1,075	Bucks.	,, ,,	Upward and downward filtration	3	Thames	21	,, ,,
Worminghall	247	Bucks.	,, ,,	Pits and irrigation	2	Thames	14½	,, ,,
Bradfield	1,526	Berks.	,, ,,	Irrigation	4	Pang	4	,, ,,
Broadmoor	In Crowthorn.	Berks.	,, ,,	Irrigation	60	Loddon	13	,, ,,
Elstree	1,323	Herts.	,, ,,	Candy's tanks and irrigation	26	Colne	24	,, ,,
Harefield	2,008	Middlesex	,, ,,	Tank and irrigation	8	Colne	12¼	,, ,,
Kings Langley	1,579	Herts.	,, ,,	Tank and irrigation	2	Colne	24	,, ,,
Cogges	790	Oxon-	,, ,,	Sedimentation and irrigation	2	Windrush	6	,, ,,
Tetsworth	282	Oxon.	,, ,,	Coke and ballast filtration	—	Thame	13½	,, ,,
Abbotts Langley	3,342	Herts.	,, ,,	Irrigation	2¼	Colne	24	,, ,,
Guards Camp, Pirbright	—	Surrey	,, ,,	Closed septic filters and irrigation	5	Wey	14½	,, ,,

NOTE.—Sewage Works are being carried out at Marlborough, Watlington, Rickmansworth, Amersham, Wargrave, Chertsey and Addlestone. Sewage Disposal Schemes are under consideration for Hungerford and Burford.

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LIST D.

Name of Premises.	Situated at.	County.	Nature of Manufacture (if any).	Method of Disposal.	In the Watershed of	Miles along Streams to Thames.	Are Samples Taken.
Eynsham Leather Mills	Eynsham	Oxon	Leather	Filter presses	Evenlode	3	Yes.
Crawley Mills	Crawley	Oxon	Blanket	Settling tanks and limestone filters	Windrush	10	"
Mount Mills	Witney	Oxon	Blanket	Tanks, degreasing plant, limestone filters, and irrigation	Windrush	6	No effluent.
Witney Mills	Witney	Oxon	Blanket	Tanks, degreasing plant, limestone filters, and irrigation	Windrush	7	Yes.
Worsham Mills	Asthall	Oxon	Blanket	Dilution (small works)	Windrush	12	"
Cotswold Brewery	Northleach	Glos.	Brewery	Solids intercepted ; double contact beds ; gravel and coke filtration	Leach	15	"
Common Farm	Highworth	Wilts.	—	Irrigation	Cole	6	"
Upper Waterhay Farm	Leigh	Wilts.	—	Gravel filters ; effluent soaks away	Thames	—	No effluent.
Lower Waterhay Farm	Leigh	Wilts.	—	Gravel filters ; effluent soaks away	Thames	—	" "
Kingham Homes for Boys	Kingham	Oxon	—	Double contact beds	Evenlode	24	Yes.
Wolvercote Mill	Wolvercote	Oxon	Paper	Bleach grouts and dark liquor placed on land ; no effluent. Backwater from machines to settling ponds.	Thames	—	"
Sandford	Sandford	Oxon	Paper	Settling ponds and coke filter screens	Thames	—	"
Bignell House	Bicester	Oxon	—	Tanks and clinker filters	Cherwell	15	"
Littlemore (County Asylum)	Littlemore	Oxon	—	Irrigation	Minchery Brook	1½	"
Hook Norton Brewery	Hook Norton	Oxon	Brewery	Special treatment (Naylor's) anti-souring ; sprinkler and continuous filter.	Cherwell	38	"
Cothill House School	Dry Sandford	Berks.	—	Tanks, filters, and irrigation	Ock	4½	"
Aston Clinton House and Stables	Aston Clinton	Bucks.	—	Charcoal filters	Thame	37½	"
Rowsham Brewery	Rowsham	Bucks.	Brewery	Solids intercepted ; gravel filters	Thame	33	"
Crowmarsh Mills	Benson	Oxon.	Flock	Gravel filters	Thames	—	"
Royal Stag Brewery	Wooburn	Bucks.	Brewery	Refuse conveyed to a catchpit and cesspools	Wye	1½	No effluent.
Shiplake Paper Mills	Shiplake	Oxon	Paper	Gravel filtration	Thames	—	Yes.

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New Mills	Henley	Oxon	Paper	Tanks and filters; irrigation	Thames	—	Yes.
Temple Mills	Bisham	Berks.	Paper	Backwater from engines diluted	Thames	—	„
Marlow Paper Mills	Marlow	Bucks.	Paper	Filters	Thames	—	„
Cookham Paper Mills	Cookham	Berks.	Paper	Settling ponds and filters	Thames	—	„
Hedsor Paper Mills	Hedsor	Bucks.	Millboard	Irrigation	Wye	¼	No effluent.
Taplow Paper Mills	Taplow	Bucks.	Paper	Contact beds	Thames	—	Yes.
Gunpowder Mill	Wooburn	Bucks.	Millboard	Irrigation	Wye	½	No effluent.
Princes Mill	Wooburn	Bucks.	Millboard	Tanks; refuse used over and over again	Wye	¾	„
Soho Mill	Wooburn	Bucks.	Paper	Settling ponds; bleach grouts to pit below level of river; fibre catchers are fitted; save-alls on machinery; soda is recovered; gas liquor; no overflow.	Wye	1½	Yes.
Lower Glory Mill	Wooburn	Bucks.	Millboard	A rendered brick tank and beds. Refuse water used over and over again.	Wye	2¾	No effluent.
Glory Mill	Wooburn	Bucks.	Paper	Series of settling beds; bleach grouts to pits; no overflow; gas liquor dealt with.	Wye	3	Yes.
Hedge Mill	Loudwater	Bucks.	Millboard	Tanks; refuse used over and over again	Wye	3½	No effluent.
Snakeley Mill	Loudwater	Bucks.	Blotting paper	Filters (up and down); bleach grouts to vat; boiler liquor to pit; no overflow.	Wye	4	Yes.
Loudwater Mill	Loudwater	Bucks.	Blotting paper	Filters, upward and downward; bleach grouts over land; boiler liquor to pit; no overflow.	Wye	4½	„
King's Mill	Loudwater	Bucks.	Blotting paper	Settling ponds; bleach grouts placed over land	Wye	4¾	„
Wycombe Marsh Mill	Wycombe	Bucks.	Paper	Tanks, filters, and presses	Wye	5½	„
Rye Mill	Wycombe	Bucks.	Paper	All drainage goes to the Corporation's sewers	Wye	6½	No effluent.
Abbott's Works	Wycombe	Bucks.	Fellmongers	Rubble filters and dams	Wye	5	Yes.
Bledlow Mill	Bledlow	Bucks.	Paper	Filters and irrigation	Thame	26	„
Halton Park	Halton	Oxon	——	Filters and irrigation	Thame	12	„
Easthampstead Park	Easthampstead	Berks.	——	Beds and filters	Loddon	11½	„
Wixenford College	Wokingham	Berks.	——	Irrigation	Loddon	11	„
Littlecote Park	Chilton Foliat	Wilts.	——	Septic tank; effluent pumped to high land where it soaks away	Kennet	31½	No effluent.
Horris Hill College	Highclere	Hants	——	Septic tank; contact beds; irrigation	Kennet	19	Yes.
Pinewood Sanatorium	Wokingham	Berks.	——	Septic tank and treble contact beds	Loddon	10	„
St. Andrew's College	Bradfield	Berks.	——	Irrigation; soaks away into chalk	Pang	5	No effluent.

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Name of Premises.	Situated at.	County.	Nature of Manufacture (if any.)	Method of Disposal.	In the Watershed of	Miles along streams to Thames.	Are samples taken.
Wokefield Park	Stratfield Mortimer	Berks.	——	Irrigation ; soaks away	Loddon	13	No effluent.
The Priory	Beech Hill	Berks.	——	Tank, filter, and irrigation ; soaks away	Loddon	12	„
Aldermaston Court	Aldermaston	Berks.	——	Irrigation ; soaks away	Kennet	12	„
Aldermaston Brewery	Aldermaston	Berks.	Brewery	Irrigation ; soaks away	Kennet	12	„
Benham Park House	Speen	Berks.	——	Contact beds and irrigation ; soaks away	Kennet	21	„
Benham Kennels	Speen	Berks.	——	Contact beds and irrigation ; soaks away	Kennet	21	„
Sulhampstead House	Sulhampstead Abbotts.	Berks.	——	Irrigation ; soaks away	Kennet	8	„
Newlands House	Arborfield	Berks.	——	Irrigation ; soaks away	Loddon	7½	„
Stratfieldsaye House	Stratfieldsaye	Hants.	——	Drainage pumped to pits on high land and soaks away	Loddon	14	„
The Manor House	Sherfield on Loddon.	Hants.	——	Contact beds and irrigation ; soaks away	Loddon	17	„
Tylney Hall	Rotherwick	Hants.	——	Septic filters and irrigation ; soaks away	Loddon	19	„
Beaurepaire Park	Sherborne St. John.	Hants.	——	Tanks and irrigation ; soaks away	Loddon	21	„
Elvetham House	Elvetham	Hants.	——	Screening chambers, irrigation ; soaks away	Loddon	23	„
Waltham Brewery	Waltham St. Lawrence.	Berks.	Brewery	Settling beds and irrigation ; soaks away	Loddon	6½	„
The Manor House	Ogbourne Maisey.	Wilts.	——	Septic tanks, coke filters and irrigation ; soaks away	Kennet	41	„
Colthrop Mills	Thatcham	Berks.	Paper	Settling beds, ash filters and irrigation	Kennet	15½	Yes.
West Drayton Mill	West Drayton	Middlesex	Millboard	Tanks, refuse water is used over and over again	Colne	5½	No effluent.
Croxley Mill	Rickmansworth	Herts.	Paper	Settling beds, filtration (upward and downward) ; bleach grouts and boiler liquor to pits, no overflow.	Colne	17	Yes.
Rickmansworth Brewery	Rickmansworth	Herts.	Brewery	Tanks and filters ; will be connected to main sewers when the town scheme is completed.	Colne	15½	„
Asbestos Mill	Harefield	Middlesex	Asbestos	Tanks and filters	Colne	12½	„
Mill End Mill	Rickmansworth	Herts.	Blotting Paper	Irrigation ; will join Rickmansworth sewers when completed	Colne	16	„
Hamper Mill	Watford	Herts.	Tracing Paper	Dilution	Colne	17	„
Two Waters Mill	Hemel Hempstead.	Herts.	Paper	Mill closed	Colne	25½	No effluent.

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Apsley Mill	Hemel Hempstead.	Herts.	Cardboard Boxes	Contact beds	Colne	26	Yes.
Nash Mill	Hemel Hempstead.	Herts.	Paper	Dilution	Colne	24	„
Home Park Mill	King's Langley	Herts.	Paper	Small tanks	Colne	22½	„
Frogmore Mill	Hemel Hempstead.	Herts.	Paper	Settling beds	Colne	25	„
The Weirs Mills	Oxford	Oxon.	Cardboard	Refuse used over and over again (very small works)	Thames	—	No effluent.
Towle's Mills	Oxford	Oxon.	Cardboard	Refuse used over and over again (very small works)	Thames	—	„
Hillingdon House	Hillingdon	Middlesex	—	Tanks and filters	Colne	8	Yes.
Pendley Manor	Tring	Herts.	—	Tanks and sprinkler filter beds	Colne	33	„
Royal Hotel	Albury	Herts.	—	Tanks and contact beds	Colne	33	„
Cassio Park	Watford	Herts.	—	Filters	Colne	17	„
Poyle Mill	Poyle	Middlesex	Blotting Paper	Settling beds and breeze filters	Colne	3½	„
Wraysbury Mill	Wraysbury	Bucks.	Blotting Paper	Settling beds	Colne	2	„
Thorney Mill	Iver	Bucks.	Blotting Paper	Closed	Colne	4	„
Farncombe Mill	Godalming	Surrey	Paper	Tanks; antichlor used; fibre; bleach grouts disposed of over land; no boiling.	Wey	18½	„
Gosden Tannery	Shalford	Surrey	Tannery	Settling bed, filters; the sludge is air dried	Wey	18	„
Gomshall Brewery	Shere	Surrey	Brewery	Tank and filters; will eventually join Gomshall Sewerage System	Wey	20½	„
Gilligan's Tannery	Shere	Surrey	Tannery	Settling tanks, land filters; negotiations to join sewerage system in progress.	Wey	20½	„
King's Mills	Alton	Hants.	Paper	Settling ponds	Wey	38	„
"The Garlands"	Ewhurst	Surrey	—	Tank and clinker filter	Wey	26	„
Anningsley Park	Ottershaw	Surrey	—	Tank and filter	Bourne	4	„
Woodhill House	Wonersh	Surrey	—	Tanks and coke filters	Wey	19	„
Woodcote House School	Windlesham	Surrey	—	Tanks and coke filters and irrigation	Bourne	12	„
Spooner's House	Bagshot	Surrey	—	Ash filters	Bourne	11½	„
The Holloway Sanatorium	Egham	Surrey	—	Septic tanks, filters and irrigation	Bourne	7	„
The Holloway College	Egham	Surrey	—	Tanks and irrigation; soaks away	Bourne	7½	No effluent.
Mousehill Manor House	Witley	Surrey	—	Tanks and irrigation; soaks away	Wey	20	„
Kingsdown Brewery	Stratton St. Margaret.	Wilts.	Brewery	Tanks and irrigation; soaks away	Ray	13	„

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Mr. F. A. W.
Drummond,
and Mr.
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APPENDIX B. to Mr. Philipson's Evidence.—THAMES CONSERVANCY.—LIST D.—*continued*

Name of Premises.	Situated at.	County.	Nature of Manufacture, if any.	Method of Disposal.	In the Watershed of	Miles along streams to Thames.	Are samples taken.
Marlow Brewery - - - - -	Great Marlow -	Bucks. -	Brewery - -	Tanks and irrigation ; soaks away - - - - - - - -	Thames - - -	—	No effluent.
Broadford Brewery - - - - -	Shalford - -	Surrey -	Brewery - -	Tanks, contact beds and irrigation ; soaks away - - - -	Wey - - -	15	„
L.C.C. Industrial School - - - -	Woking - -	Surrey -	——	Connected to local sewers - - - - - - - - - -	Wey - - -	11	„

See Question No. 19305 in the Evidence given before the Royal Commission on Sewage Disposal.

AT the undermentioned places the refuse liquid from Breweries, Brewery Stores and Maltings is taken into the Local Authorities' Sewerage Systems and finally dealt with at the Sewage Disposal Works.

Swindon.
Eynsham.
Newbury.
Banbury.
Abingdon.
Aldershot.
Tring.
Staines.
Guildford.

Cirencester.
Henley.
Wokingham.
Windsor.
Wycombe.
Alton.
Watford.
Stanmore.
Cranleigh.

Oxford.
Chipping Norton.
Wantage.
Wallingford.
Wendover.
Hartley Wintney.
Hemel Hempstead.
Uxbridge.
Farnham.

Witney.
Faringdon.
Reading.
Maidenhead.
Basingstoke.
St. Albans.
Berkhamsted.
West Drayton.

APPENDIX B. to Mr. Philipson's Evidence.—THAMES CONSERVANCY.—*continued*

LIST E.

Situated at	Company or Private.	Coal, Oil or Water.	Is Sulphate made?	How Tar and Ammoniacal liquor are disposed of.	Remarks.
Faringdon	Company	Coal	Yes	Tar sold locally: liquor burnt	No pollution of any stream.
Cirencester	Company	Coal	Yes	Tar and liquor sent to Gloucester by rail.	,, ,,
Eynsham	Company	Coal	No	Tar and liquor sent to Gloucester by rail.	,, ,,
Charlbury	Company	Coal	No	Tar and liquor sold locally	,, ,,
Woodstock	Company	Coal	No	Tar and liquor sold locally	,, ,,
Bruern	Private	Oil	No	Tar and liquor to pits in meadow; no overflow.	,, ,,
Chipping Norton	Company	Coal	Yes	Tar sold locally: liquor burnt up	,, ,,
Highworth	Company	Coal	Yes	Tar sold locally, liquor used over land.	,, ,,
Witney	Company	Coal	No	Tar and liquor sent to Wolverhampton by rail.	,, ,,
Shipton-under-Wychwood.	Company	Coal	Yes	Tar sold locally, liquor over allotments.	,, ,,
Northleach	Company	Coal	Yes	Tar sold locally, liquor burnt	,, ,,
Cricklade	Company	Coal	No	Tar sold locally, liquor burnt	,, ,,
Burford	Company	Water	No	Tar sold locally, liquor burnt	,, ,,
Fairford	Mr. Brown	Coal	No	Tar sent to Swindon, liquor burnt	,,
Stow-on-the Wold	Company	Coal	No	Tar and liquor sold locally	,, ,,
Moreton-in-the Marsh	Company	Coal	No	Tar and liquor sold locally	,, ,,
Old Swindon	Company	Coal	No	Tar and liquor sent to Bristol by Rail and Canal.	,, ,,
New Swindon	Company	Coal, oil and water	Yes	Worked up on premises and disposed of.	,, ,,
G.W. Works, Swindon	G.W. Railway Co.	Coal	No	Sent to Bristol by Rail	,, ,,
Bourton-on-the-Water	Company	Coal	Yes	Tar sold, liquor sent to Gloucester by Rail.	,, ,,
Oxford	Company	Coal	No	Tar and liquor sent to Oldbury by Oxford Canal.	,, ,,
Banbury	Company	Coal	No	Tar and liquor sent to Oldbury by Oxford Canal,	,, ,,
Bicester	Company	Coal	No	Tar and liquor sent to Beckton by L. and N.W. Railway.	,, ,,
Abingdon	Company	Coal	No	Tar and liquor sent to Swindon by G.W. Railway.	,, ,,
Wantage	Company	Coal	No	Tar and liquor sent to Swindon by G.W. Railway.	,, ,,
Didcot	G.W. Railway Co.	Coal	No	Tar and liquor sent to Swindon by G.W. Railway.	,, ,,
Deddington	Company	Coal	No	Tar sold locally, liquor burnt	,, ,,
Bloxham	Company	Coal	No	Tar sold locally, liquor burnt	,, ,,
Sandford	Private	Coal	No	Tar sold locally, liquor burnt	,, ,,
Wolvercote	Private	Coal	No	Tar sold locally, liquor burnt	,, ,,
Littlemore	County Asylum	Coal	No	Tar sold locally, liquor burnt	,, ,,
Wootton Underwood	Private	Coal	No	Tar sold locally, liquor over land	,, ,,
Aylesbury	Company	Coal	No	Tar and liquor sent to Birmingham by Grand Junction Canal.	,, ,,
Aston Clinton	Rothschild	Coal	No	Tar sold, liquor over land	,, ,,
Beaconsfield	Company	Coal	No	Tar sold, liquor over land	,, ,,
Great Marlow	Company	Coal	No	Tar sold, liquor burnt	,, ,,
Wooburn (Glory Mill)	Private	Oil	No	Tar and liquor burnt, or sent to London per Great Western Ry.	,, ,,
Hambledon	Hon. W. F. D. Smith	Coal	No	Tar and liquor burnt	,, ,,
Cleeve	Company	Coal	No	Tar and liquor sent to London per Great Western Railway.	,, ,,
Halton	Rothschild	Coal	No	Tar used on estate, liquor burnt	,, ,,
Henley-on-Thames	Company	Coal	No	Tar and liquor sent to Bristol per Great Western Railway	,, ,,
High Wycombe	Company	Coal	Yes	Tar and liquor sent to London per Great Western Railway	,, ,,

Mr. R. Philipson, Mr. F. A. W. Drummond, and Mr. C. E. Groves.

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APPENDIX B to Mr. Philipson's Evidence.—THAMES CONSERVANCY.—LIST E—*continued.*

Situated at	Company or Private.	Coal, Oil, or Water.	Is Sulphate made ?	How Tar and Ammoniacal liquor are disposed of.	Remarks.
Loudwater Mill	Private	Oil	No	Tar and liquor destroyed	No pollution of any stream.
Taplow	Company	Coal, Oil and Water	No	Tar and liquor sent to Silvertown (Burt & Co.) by river.	,, ,,
Pangbourne	Company	Coal	No	Tar sold locally, liquor burnt	,, ,,
Princes Risborough	Company	Coal	No	Tar sold locally, liquor burnt	,, ,,
Slough	Company	Coal	No	Tar sold, liquor sent to Brentford, per Great Western Railway.	,, ,,
Soho Mill, Woburn	Private	Coal	No	Tar sold, liquor burnt	,, ,,
Thame	Company	Coal	No	Tar to Birmingham, locally to Wolverhampton, per G. W. Ry.	,, ,,
Tring	Company	Coal	No	Tar to London by Grand Junction Canal, liquor burnt.	,, ,,
Waddesdon	Company	Coal	No	Tar and liquor sent to London, per Great Western Railway.	,, ,,
Wallingford	Company	Coal	No	Tar burnt, liquor to Abingdon, per Great Western Railway.	,, ,,
Watlington	Company	Coal	No	Tar sold locally, liquor burnt	,, ,,
Wendover	Company	Coal	No	Tar sold locally, liquor over land	,, ,,
Windsor	Company	Coal	No	Tar by river to London, liquor to Bristol, per Great Western Ry.	,, ,,
Odiham	Company	Coal	No	Tar sold, liquor burnt	,, ,,
Basingstoke	Company	Coal	Yes	Tar sold, liquor burnt	,, ,,
Reading	Company	Coal	Yes	Tar sold, liquor burnt	,, ,,
Twyford	Company	Coal	No	Tar sold, liquor burnt	,, ,,
Aldershot Town	Company	Coal	Yes	Tar sold, liquor used up, part to sewers.	,, ,,
York Town	Company	Coal	No	Tar sold ; liquor sent to Aldershot Gas Company.	,, ,,
Sandhurst	War Department.	Coal	Yes	Tar used up ; liquor used up	,, ,,
Theale	Company	Coal	No	Tar sold locally ; liquor burnt	,, ,,
Bearwood	Mr. Walters	Coal	No	Tar and liquor used on Mr. Walters' estate.	,, ,,
Thatcham	Company	Coal	No	Tar sold ; liquor by road to Newbury Gas Works.	,, ,,
Kingsclere	Company	Coal	No	Tar sold ; liquor disposed of to farmers.	,, ,,
Sulhampstead	Private	Coal	No	Tar used ; liquor over land	,, ,,
Englefield	Private	Coal	No	Tar used ; liquor over land	,, ,,
Broadmoor	Home Office.	Coal	No	Tar used ; liquor over land	,, ,,
Hartley Witney	Company	Coal	No	Tar sold ; liquor sent to Southampton, per London and South Western Railway.	,, ,,
Lambourne	Company	Coal	No	Tar sold ; liquor used over land locally.	,, ,,
Hungerford	Company	Coal	No	Tar sold ; liquor burnt	,, ,,
Newbury	Corporation.	Coal	Yes	Tar sold ; liquor used on premises : rest to sewers	,, ,,
Kintbury	Not in use.	—	—	——	,, ,,
Wokingham	Corporation.	Coal	No	Tar sold ; liquor sent to Newbury Gas Works by rail.	,, ,,
Easthampstead Park	Private	Coal	No	Tar and liquor used on estate (Marquis of Downshire's).	,, ,,
Marlborough	Company	Coal (Dawson's)	No	Tar and liquor to Bristol, per Great Western Railway.	,, ,,
Marlborough Water Works.	Corporation.	Water	No	Tar and liquor to Bristol, per Great Western Railway.	,, ,,
Thatcham Paper Mill	Private	Coal and water	No	Tar and liquor over ground, and burnt.	,, ,,
Wellington College	Private	Coal	No	Tar and liquor sent by rail to Sandhurst Gas Works.	,, ,,
Amersham	Company	Coal	No	Tar to London ; liquor to Pinner Gas Works.	,, ,,
Boxmoor	Company	Coal	Yes	Tar to Silvertown (Burt's) ; liquor used up.	,, ,,
Boreham Wood	Company	Coal	No	Tar used for heating retorts ; liquor burnt.	,, ,,
Berkhamsted	Company	Coal	No	Tar by rail to London ; liquor to local farmers.	,, ,,
Colnbrook	Company	Coal	No	Tar sold locally ; liquor burnt	,, ,,

Mr. R. Philipson, Mr. F. A. W. Drummond, and Mr. C. E. Groves.

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APPENDIX B. to Mr. Philipson's Evidence.—THAMES CONSERVANCY.—LIST E.—*continued.*

Situated at	Company or Private.	Coal, Oil or Water.	Is Sulphate made?	How Tar and Ammoniacal liquor are disposed of.	Remarks.
Chesham - - -	Company	Coal - -	No -	Tar sent to Poplar; liquor burnt -	No pollution of any stream
Harefield Asbestos Works	Private	Oil - -	No -	Tar and liquor burnt - - -	,, ,,
Hunton Bridge - -	Company	Coal - -	No -	Tar to London by Grand Junction Canal; liquor burnt.	,, ,,
Harpenden - - -	Company	Coal - -	No -	Tar and liquor sent per rail to Burton (Worthington's).	,, ,,
Leavesden Lunatic Asylum.	—	Coal - -	No -	Tar to London, per Grand Junction Canal; liquor over land.	,, ,,
Pinner - - - -	Company	Coal - -	Yes -	Tar sold; liquor used up - -	,, ,,
Rickmansworth - -	Company	Coal - -	No -	Tar and liquor, by Grand Junction Canal, to London.	,, ,,
Redbourn - - -	Company	Coal - -	No -	Tar sold; liquor, per London and North Western Railway, to Silvertown (Burt's).	,, ,,
St. Albans - - -	Company	Coal - -	Yes -	Tar to London by rail; liquor used.	,, ,,
Uxbridge - - -	Company	Coal - -	Yes -	Tar to London by Grand Junction Canal; liquor used.	,, ,,
Watford - - -	Company	Coal and oil.	Yes -	Tar to London by Grand Junction Canal (to Grindley & Co.); liquor used.	,, ,,
Markyate - - -	Company	Coal - -	No -	Tar sold locally; liquor burnt -	,, ,,
Virginia Water - -	Sanatorium	Coal - -	No -	Tar and liquor used up on premises	,, ,,
Godalming - - -	Company	Coal - -	Yes -	Tar to London, per London and South Western Railway; liquor used.	,, ,,
Farnham - - -	Company	Coal - -	No -	Tar and liquor to Southampton, per London and South Western Railway.	,, ,,
Guildford - - -	Company	Coal and oil.	Yes -	Tar sent per London, Brighton and South Coast Railway; liquor used.	,, ,,
Haslemere - - -	Company	Coal and oil.	No -	Tar sent per London and South Western Railway to Portsmouth; liquor burnt.	,, ,,
Chertsey - - -	Company	Coal and oil.	No -	Tar sent to West Ham, per London and South Western Railway; liquor burnt.	,, ,,
Woking - - - -	Company	Coal and oil.	Yes -	Tar to Silvertown (Burt's), per London and South Western Railway.	,, ,,
Witley - - - -	King Edward's School.	Coal and oil.	No -	Tar and liquor used on premises -	,, ,,
Cranley - - - -	Company	Coal and oil.	No -	Tar to London, per London, Brighton and South Coast Railway; liquor burnt.	,, ,,
Alton - - - -	Company	Coal and oil.	No -	Tar and liquor to Southampton, per London and South Western Railway.	,, ,,
Sunninghill Ascot - -	Company	Coal and oil.	No -	Tar and liquor to Southampton, per London and South Western Railway.	,, ,,
Brookwood - - -	Asylum	Coal and oil.	No -	Tar to Poplar, per London and South Western Railway; liquor to Guildford Gas Works, per rail.	,, ,,
Bagshot - - - -	Not in use	—	—	—	—
Walton-on-Thames -	Company	Coal - -	Yes -	Tar, by barge, to various parts; liquor used.	,, ,,
Egham - - - -	Company	Coal and Water.	No -	Tar and liquor to London, by barges.	,, ,,

R. Philipson,
Secretary

Mr.
R. Philipson,
Mr. F. A. W.
Drummond,
and Mr.
C. E. Groves.

20 Oct. 1903.

APPENDIX C TO MR. PHILIPSON'S EVIDENCE.

Thames Conservancy,
Victoria Embankment, E.C.
25th November, 1903.

SIR,

Section 98, T. C. Act, 1894.

I beg to advert to your letter of the 4th August last, and, in reply to the Commissioners' request to be informed what alterations in the law the Conservators consider desirable for the prevention of pollution and the protection of water supplies, to inform you that the Conservators are of opinion that their powers for the prevention of the pollution of the Thames and its tributaries should be extended in the direction indicated in the statement annexed.

I am, Sir,
Your obedient Servant,
R. PHILIPSON.
Secretary.

The Secretary,
Royal Commission on Sewage Disposal.

THAMES CONSERVANCY.

(1) The portions of the counties of Sussex, Northampton, Warwick, Worcester, and Bedford which are within the Thames watershed, but in respect of which the Conservators' powers do not apply, should be brought within the scope of the Thames Conservancy Act, 1894.

Note.—The object is to bring the whole of the watershed above London within the Conservators' jurisdiction. At present their jurisdiction is limited to the Counties named in Section 90.

It is estimated that, by such extension, some 45 additional places, with a population of 27,500 persons, would be brought under the Conservators' control, and that the area within which they exercise jurisdiction would be increased by 158 *square miles*, or 101,120 *acres*. Of these 45 places, over 30 are on the River Cherwell, *above* the town of Banbury in Oxfordshire, which takes the whole of its water for *domestic supply* from the Cherwell.

The present limited jurisdiction has caused difficulty in the past. For instance, the Conservators required the Local Authority at *Moreton-in-the-Marsh* (Gloucestershire), on the river Evenlode, to discontinue the pollution of that stream, and took legal proceedings against them. When the summons was heard, Counsel appearing for the Local Authority asked why they were prosecuted, *whilst places lower down the same tributary, and which polluted the river*, were not interfered with. These places are in Worcestershire, and therefore beyond the reach of the Act.

(2) The restriction imposed in Section 92 of the Thames Conservancy Act, 1894, limiting the Conservators' powers, of dealing with refuse from manufactories to three miles up the tributaries above the Metropolis should be abolished.

Note.—The three-mile limit has led to difficulties in dealing with refuse from manufactories, especially paper mills. Mention may be made of the following cases on the Wycombe Stream in Bucks:—

(A) *Wycombe Marsh Paper Mill* (five miles from the Thames). The use of China clay causes the discharge from the mill to discolour the stream, making the water appear like milk. The Conservators' chemist has been unable to prove that the discharge is "offensive or injurious" within the meaning of the Thames Act, and the Conservators cannot deal with it as *factory refuse*.

(B) *Loudwater Paper Mill* (4½ miles from the Thames). The stream has been discoloured by pink, blue, and other colours used in the manufacture of blotting paper.

Similar discolouration has occurred at *Glory* and *Snakeley Mills*, but for the reasons above stated, the Conservators cannot prevent it.

The effect of the removal of the restriction would obviously be a considerable extension of the Conservators' powers.

(3) The Conservators' powers under Section 98 of the Thames Conservancy Act, 1894, should be extended so far as to allow of their Officers entering and inspecting sewage works and sewage farms, and works and manufactories at any time, instead of only between the hours of 9 a.m. and 4 p.m.

Note.—At present, the Conservators' Officers can legally only enter lands and premises for the purpose of inspection between the hours named above. This is sufficient in the case of private premises and dwelling houses; but as there is reason to believe that pollution has been passed into the streams from paper works at night time, power is required to enable the Officers to pay surprise visits to sewage works and manufactories after working hours, and during the night.

(4) Power should be given to the Conservators to secure that mill owners, when removing mud from mill-ponds and mill-heads, shall dispose of the mud on land, instead of stiring it up and passing it down stream.

Note.—These powers are sought to enable Conservators to put a stop to an objectionable practice which prevails on the Wycombe stream.

Mill owners, when desirous of removing accumulations of mud from their mill-heads, *stir up* the mud, and then open sluices and pass it down stream, causing, it is alleged, serious destruction of fish.

The Conservators contend that where millowners wish to get rid of the mud, they should be *compelled, by statute, to take it out of the stream* and *dispose of it on land*.

R. PHILIPSON,
Secretary.

SIXTY-FIFTH DAY.

Wednesday, 21*st October* 1903.

PRESENT:

The Right Honourable the Earl of IDDESLEIGH (*Chairman*), presiding.

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P.
Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Mr. W. H. POWER, C.B., F.R.S.
Colonel T. W. HARDING, J.P.
Mr. F. J. WILLIS, *Secretary*.

Also Present:

Dr. A. C. HOUSTON. Dr. H. T. BULSTRODE.

Dr. T. J. BROWNE, Medical Inspector of the Local Government Board, Ireland, and Professor E. J. McWEENEY, M.A., M.D., D.P.H., called in; and Examined.

Dr. T. J. Browne and Professor E. J. McWeeney, M.A., M.D., D.P.H.

21 Oct. 1903.

(*Chairman.*) Dr. Browne, you have given us a very nicely-arranged paper of the evidence you would give to the Commission, and I should propose that it should go straight on to our minutes?—Yes, my Lord, the evidence is arranged under the following headings:—

1. The extent and nature of the shellfish industry in Ireland.

2. The condition of the layings as ascertained by a local survey in regard to contamination.

3. The causation of enteric fever and other illness by the consumption of contaminated shellfish.

4. The way in which this danger may be removed.

5. The considerations which would guide me in determining whether a laying, etc., was liable to contamination to such an extent that it should be regarded as dangerous.

6. Remedies suggested.

(1) Estimate of the Extent and Nature of the Shellfish Industry in Ireland.

The estimated annual output of oysters from public fisheries and private layings on the Irish littoral, as ascertained by me by inquiry from local sources, is as follows:—

Public fisheries - - -	6,000,000
Chartered oyster layings:	
1. Native oysters - - -	1,000,000
2. Foreign oysters - - -	25,000,000
Licensed oyster beds or layings:	
1. Native oysters - -	2,000,000
2. Foreign oysters - - -	5,050,000
Unlicensed oyster layings:	
1. Native oysters - - -	200,000
2. Foreign oysters - - -	6,000,000
Total - - - -	45,250,000

Of the above total, 9,200,000 are native oysters and 36,050,000 foreign oysters.

Mussels.—The total annual output is about 2,000 tons.

Cockles.—Total collected annually, about 1,000,000 gallons.

Periwinkles.—Total collected annually, about 1,500 tons.

Nature of Shellfish Industry.

Oysters.

The oysters are of two classes, native and foreign. The native oysters are raised from spat, chiefly on the public fisheries at Tralee Bay, Carlingford Lough, Kinvarra and Tyrone Bays, Galway, Kilkerrin Bay, Galway, and estuary of River Lee, Cork. The oysters from these fisheries are dredged during the open season, which varies from one to eight months of the year, and are for the most part disposed of to owners of private layings, to lay on their beds to grow and fatten, as the oysters are, as a rule, too small and in too poor a condition for market. Those fit for use are disposed of to local dealers, and are sent off direct from the fisheries to customers in the large cities and towns in England and Ireland.

The oysters which are laid on private layings remain on the beds for varying periods, from one to three years, and are then disposed of to customers throughout the country and in the large centres of population in England, principally to clubs, hotel and restaurant proprietors, etc., etc.

The oysters are sent off direct from the laying, carefully packed, as a rule, in boxes or baskets with seaweed, to their destination by rail and steamboat. Some consignments of small quantities are sent by parcel-post to private customers.

Consignments to regular customers are sent off two or three times each week, and are kept in the boxes in which they are sent for two or three days, at most, until finally disposed of for consumption. The foreign oysters come chiefly from Brittany and America. Those from the former locality are young brood, and are procured for the purpose of stocking private layings, on which they remain for periods varying from two to three or four years before being sent to market. They are then disposed of in a similar manner as the native oysters.

The American oysters are shipped from East River and Blue Point in large quantities packed in barrels during the months of March, April, and May. Each barrel contains from 1,000 to 1,300 oysters. A certificate of freedom from contamination, issued by the Local Board of Health, accompanies each consignment. The time occupied in transit varies from 10 to 16 days. Frequently many of the oysters on top of the barrel are found to have perished on arrival at destination. The oysters are packed closely in the barrels, without water or other substance. Many of the oysters perish after being laid on the beds, which probably is due to their long sojourn out of their native element. The oysters are shipped in the first instance to Liverpool, and from there they are sent over to the Irish layings, sometimes by special steamer, but more generally by the ordinary cross-channel steamers. The oysters remain on the layings for periods varying from a week to six months, and are disposed of in the English markets almost entirely during the close season for native oysters, viz., from 1st May till 1st September. They are sold at a cheap rate, principally at seaside resorts and in large centres of population. The principal layings for American oysters are at Carlingford Lough, Dublin Bay, and Malahide. A few thousands are laid annually in Ballysodare Bay, co. Sligo. The oysters are sent off from the layings, generally in large quantities, packed in barrels in a similar way to which they arrived at the layings; sometimes they are sent in bags.

Dr. *T. J. Browne, and Professor E. J. McWeeney,* M.A., M.D., D.P.H.

21 Oct. 1903.

Mussels.

Mussels are collected chiefly in Belfast Lough, estuary of River Maine, co. Kerry, Dundalk Bay, estuary of River Boyne, and Wexford Harbour. They are exported packed in bags, chiefly to the Liverpool, Manchester Glasgow, and Bristol markets, and are used largely for bait, but are also used as food, either in their raw state or cooked. Mussels are not used for edible purposes in Ireland, except on a very small scale by persons who collect them themselves.

Cockles.

Cockles are collected principally on the strands in Dublin bay, Dundalk Bay, Ballycastle, estuary of River Suir, Wexford Harbour, Belfast Lough, Kinsale, Strangford Lough, Ballysodare Bay, and Dundrum Bay. They are disposed of for the most part locally, and are eaten cooked and also in their raw state. A very small quantity is exported.

Periwinkles.

Periwinkles are collected all round the coast of Ireland, and are exported chiefly to the Liverpool, London, and Manchester markets. They are, I am informed, always eaten after being cooked to a more or less extent. They are not used as food in Ireland, except to a very limited extent.

(2) The Condition of the Layings, as ascertained by a Local Survey, in regard to Contamination.

Having regard to the local circumstances, proximity to sewer outfalls, and other possible sources of contamination, I have made the following classification of oyster fisheries and layings :—

(a) Those which are apparently free from contamination.

(b) Those the purity of which must be regarded as doubtful.

(c) Those which appear to be undoubtedly contaminated.

(a) Those which I consider free from pollution are situate as follows :—

All fisheries and layings in Galway Bay and inlets, with the exception of the public oyster fishery close to the docks at Galway town.

The fisheries and layings in Burtonboy Bay, Cashel Bay, Ardbear and Mannin Bays, Ballinakill Bay and inlets, Killary Bays, except fishery close to village of Leenane, Clew Bay, Newport Bay, Achill Island and Sound, Blacksod Bay, except public fishery and private layings close to Belmullet town, Drumcliffe Bay, Ballysodare Bay, with possibly the exception of Messrs. Browne and Phibbs' layings, Lough Swilly, St. George's Channel deep-sea fisheries, Roaring Water Bay, Barrow Harbour, Kenmare River, with possibly the exception of the layings at Kilmackilloge, Derryguinna, and Greenane layings, Carrig Island, and public fisheries in River Shannon.

(b) The doubtful fisheries and layings are situated as follows :—

The Kilmakilloge Harbour, Derryquinna and Greenane layings in Kenmare River, Ilen River fishery, estuary of Bandon River near Kinsale, Fishery in Glandor Harbour, Killala Bay, Messrs. Brown's and Phibbs' layings in Ballysodare Bay, Lough Foyle, Fota Channel in Cork Harbour, Aghamarta layings, Carrigaline River, layings in estuary of Ballinacurra River, Tralee Bay, public oyster fishery, layings in Clifden Bay, public fishery near Leenane village in Killary Bay, layings in Malahide inlet, and Carlingford Lough public fisheries.

(c) The fisheries and laying which appear to be undoubtedly polluted are situated as follows :—

Public fishery in estuary of River Lee, Cork Harbour, public fishery close to docks, Galway town, fishery and layings close to Belmullet town, Sligo Bay fisheries and layings, Belfast Lough, public fisheries and layings in Newry River, layings in Dublin Bay.

As regards the layings classified as doubtful, I think it right to mention that the possibility of contamination in some instances was so slight as scarcely to warrant their being included under this heading, and probably the bacteriological examination of the oysters, water, and ground formation from these layings may go to show that they are free from contamination. In this category may be included the layings in Fota Channel in Cork Harbour, Kilmackeloge Harbour in Kenmare River, Clifden Bay, Killala Bay, Killary Bay, and Ballysodare Bay. The possible contaminating sources could be removed in some cases with little trouble and at small expense.

In the case of the fisheries and layings classified as polluted, they are situated in the estuaries of rivers into which the crude sewage of large centres of population such as Dublin, Belfast, Cork, Galway, Sligo, and Newry is discharged. Although the sewer outfalls are in some instances considerable distances from the layings, still, having regard to the nature and volume of the sewage and to the fact that it passes over the layings in its course to the sea, pollution must necessarily take place to a greater or lesser extent, in accordance with the distance from the sewer outfalls and the extent of dilution to which the sewage has been subjected before reaching the site of the layings. It would be necessary to close these fisheries or to prohibit the taking of oysters from them direct for consumption, as it would be impracticable to divert the sewage or subject it to such purification as would render it innocuous before being discharged into the estuaries.

Mussels.

The principal mussel fisheries on the Irish littoral are at Belfast Lough, Castlemaine Harbour (estuary of River Loune), Dundalk Bay, estuary of River Boyne, Wexford Harbour, estuary of Douglas River, Cork Harbour, estuary of River Suir (Passage East, Waterford), Sligo Harbour, Ballysodare Bay, Dublin Bay, Galway Bay, and Glandore Harbour.

As regards contamination, I consider the mussels collected in Belfast Lough, Dundalk Bay, estuary of River Boyne, Wexford Harbour, Cork Harbour, Sligo Harbour, Dublin Bay, and those collected close to the dock of Galway are more or less subject to pollution, owing to the proximity of sewer outfalls.

Cockles.

Cockles are chiefly collected on the strands in Dublin Bay, Ballycastle, co. Mayo, Dundalk, Passage East, Waterford, Carrickfergus, Clifden, Wexford Harbour, Kinsale Harbour, River Lee, Dingle Bay, Sligo Harbour, Ballysodare Bay, Dundrum Bay, Belfast Lough, Courtmacsherry, and Clonakilty Bay.

I consider the strands in Dublin Bay, Dundalk Bay, Belfast Lough, Wexford Harbour, Kinsale Harbour, River Lee (Cork Harbour), Sligo Harbour, Belfast Lough, and Clonakilty Bay are more or less subject to contamination by sewage.

Periwinkles.

Periwinkles are collected all around the coast of Ireland, and from places, as a rule, far removed from sources of contamination. I was informed, however, that in some instances the periwinkles are stored pending despatch to market in situations on the foreshore, between high and low water-mark, not far removed from sewer outfalls, and in this way may possibly be subject to contamination.

(3) The Extent to which Enteric Fever or other Illness has been caused by the Consumption of Contaminated Shellfish.

There is no accurate data to go upon to show the extent. It requires careful investigation; but during the past few years I have heard from time to time of small outbreaks ascribed to the consumption of shellfish. The Medical Officer of Health of Carlingford Dispensary District of Dundalk Union states he has noticed that local outbreaks of enteric fever follow the opening of the public oyster fisheries season in estuary of Newry River. The persons attacked are the fishermen or others who have partaken of the oysters dredged from the estuary of the Newry River into which the crude sewage of Newry and Warrenpoint towns is discharged. The Medical Officer of Health and a local medical practitioner who attended some of the patients made at the time careful inquiries as to the probable source of infection, and both arrived at the conclusion that the oysters were at fault. Some months ago, when visiting the locality, I made personal inquiries into nearly all of the cases, and could discover no other likely source of infection. I ascertained that cases of

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enteric fever were under treatment in the Newry Hospital prior to the appearance of the disease in the Carlingford district. The hospital is drained into the Newry River, so that the sewage effluent would likely contain the bacillus typhosis.

During the spring and summer months of last year several cases of enteric fever occurred at Carlingford and vicinity. The outbreak was attributed by the Medical Officer of Health to the eating of cockles collected from the strand in Dundalk Bay, which is subject to pollution by the sewage from Dundalk town. On a recent visit to the locality I made personal inquiries into the circumstances connected with all of the cases, and ascertained that all had either eaten cockles obtained from Dundalk Bay some days prior to the onset of the disease, or had contracted the fever from a previous case in the same family, in which cockles were the probable source of infection. In one family I found that the only person who developed enteric fever was a child who partook of the cockles in the raw state; the other members of the family partook of the cockles cooked, and escaped infection. I failed to discover any source of infection other than the cockles. There were some cases of enteric fever under treatment in the Dundalk Hospital about the time of the occurrence of the outbreak at Carlingford.

In the month of January of the present year two cases of enteric fever were reported from Athlone. The source of infection was suspected to be oysters which the patients had eaten some days prior to the onset of the disease, and which were obtained from layings at Clontarf, near Dublin. These layings are undoubtedly subject to contamination by sewage. Other persons in Athlone who partook of oysters from the same source about the same time suffered from diarrhœa and vomiting, but did not develop enteric fever. The Medical Officer of Health states that these were the only cases of enteric fever which occurred in Athlone for a long period, and that he could not discover any other cause than the oysters as likely to give rise to the outbreak.

I may remark that so far back as 1881, Sir Charles Cameron, Medical Superintendent Officer of Health, Dublin, referred to the then polluted condition of the shores of Dublin Bay, and the danger of the shellfish being similarly polluted.

Enteric fever has been prevalent in Belfast for several years past. Dr. Whittaker, the Medical Superintendent Officer of Health, informed me that several of the sufferers had partaken of shellfish prior to the onset of the disease, but was unable to furnish me with particulars. When recently visiting Belfast I noticed several persons collecting shellfish from the polluted shores of Belfast Lough. I interrogated some of them, and found that it was a common practice for the people, when not otherwise employed, to collect shellfish on the shores of the Lough, and to bring them home for the use of their families. I was also informed that enteric fever had sometimes developed in persons who partook of the shellfish from this source.

Dr. Lorraine Smith, of Belfast, who was commissioned by the County Borough Council of Belfast to inquire into the cause of the prevalence of enteric fever in the city, refers to the shellfish as a possible factor in causing the disease.

It is only within the last 10 or 12 years that attention has been drawn to the possibility of enteric fever being caused by the consumption of shellfish taken from polluted sources, and I think it very probable that this as a possible source of infection may have frequently been overlooked, and that the number of cases arising from this cause would, if carefully investigated, probably be more numerous.

(4) The Way in which this Danger may be Removed.

The danger attendant on the consumption of shellfish from polluted sources may be averted in two ways:

(a) Either by removing the contamination, or

(b) By prohibiting the sale for human consumption of shellfish taken direct from contaminated sources, without previous relaying for a specified period in pure waters.

As regards removal of contamination, it would, I consider, be possible to do so without much trouble or expense in any instances where the pollution arose from the drainage of a small number of private houses or where the amount of pollution was slight, but in the case of pollution arising from the sewage of large centres of population this would be impracticable, owing to the question of expense. There is also the question to be considered whether any known treatment of sewage is sufficient to render it innocuous, even when the effluent is discharged at some considerable distance from the site of layings.

In the case of layings when the pollution cannot be remedied by removal, the taking of shellfish from such places direct for human consumption should be prohibited. Shellfish from such places should be laid for a specified time before sale in pure waters, so as to ensure that they would be freed from any risk of communicating disease.

(5) The Considerations which would Guide me in Determining whether a Laying was Liable to Contamination to such an Extent as to be regarded as Dangerous.

In arriving at a conclusion on this point, it would be necessary in each case to give careful consideration to the physical circumstances and topographical relations to the outlet of local sewers and drains, having regard to the nature and composition of the effluent.

In cases where the layings were situated close to the outlets of sewers, and pollution obvious, there would be no difficulty in determining the question of pollution and consequent danger to health should B. Coli organisms be contained in the effluent. On the other hand, where layings were situated at some distance from sewer outfalls, the danger would vary in accordance with the volume and nature of the sewage effluent, the direction of the currents and tides, the distance from sewer outfalls, and the expanse of water at site of layings. In such cases the chemical and bacteriological examination of the shellfish, water, and ground formation from the layings would, with the other factors mentioned, guide me in determining the question of dangerous pollution.

(6) Remedies which I would Suggest.

(a) The registration of all oyster fisheries and layings; also of places where other kinds of shellfish are taken from.

(b) No fisheries, layings, etc., should be registered unless certified as free from dangerous pollution.

(c) Exception might be made in the case of fisheries or layings used for spatting or breeding purposes only, and from which shellfish are not taken direct for human consumption.

(d) No shellfish should be permitted to be taken from polluted sources direct for human consumption.

(e) Foreign shellfish, unless it can be ascertained to have come from pure sources, should be required to be relaid in pure British water for a specified period before being put on the market for human consumption.

(f) The registration of shell-fisheries, layings, etc. as also the general supervision of the shellfish industry, might be entrusted to Rivers Boards acting under a central body, such as the Local Government Board, as suggested by the Royal Commission on Sewage Disposal.

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19360. (*Chairman.*) Well, now I should just like to ask you one or two subsidiary questions. Could you tell us the exact difference between Charter licensed and unlicensed oyster beds or layings?—Well, the Fishery Commissioners in Ireland license the beds.

19361. The difference between the Charter licensed and the unlicensed?—The Chartered beds are oyster beds that have been in existence for many centuries, I believe; at least, possibly since the time that the owner—the landlord of the property—got possession of the property, and he has a right to these, a prescriptive right to these beds. Licensed beds are beds which are licensed by the Fishery Commissioners in Ireland.

19362. (*Sir Michael Foster.*) Under what conditions are they licensed, and what power does the licence carry?—It appears that these beds are licensed so long as the beds are cultivated, and in granting the licence questions of public health are not taken into consideration at all—that is, pollution, contamination, possible contamination of the beds.

19363. But what is the difference between a licensed bed and an unlicensed bed?—Well, an unlicensed bed is simply where any person chooses to select a spot on the foreshore and lay down oysters. Probably it would be more correctly designated "layings"; these

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unlicensed beds or layings are simply used for storing oysters by dealers.

19364. But what are the privileges attached to a licensed laying or bed?—A licensed bed—it protects the owner; no one else can come and take oysters from that locality; an unlicensed bed, anyone can go there that chooses; that is the difference.

19365. (*Chairman.*) I still do not quite follow. Are there Chartered unlicensed oyster layings?—The Chartered beds are not licensed.

19366. They are not licensed?—No, they are not licensed, but the owners of the Chartered beds have a right, of course, for generations to these particular beds or layings.

18367. (*Sir Michael Foster.*) They have all the privileges of a licensed bed?—They have all the privileges of a licensed bed.

19368. They have got the privileges by a Charter, and not by a licence?—And not by a licence.

19369. (*Mr. Power.*) And is the unlicensed man liable to be dispossessed by someone who gets a licence for the ground that he has occupied?—I should say so.

19370. He has no prescriptive right?—He has no prescriptive right; he selects a spot of ground anywhere round the coast, and he utilises this for his laying oysters pending sales.

19371. (*Chairman.*) In the case of a Chartered unlicensed laying, is not the owner of that protected by his Charter?—Oh, yes, certainly.

19372. Well, is there any difference between a Chartered bed which is licensed and a Chartered bed which is unlicensed?—Oh, there are no Chartered beds licensed. Chartered beds are not licensed layings.

19373. Oh, they are not licensed?—No.

19373*. (*Sir Michael Foster.*) They are either Chartered or licensed?—Yes.

19374. (*Colonel Harding.*) By whom is the licence given?—By the Board of Agriculture in Ireland now, the Fishery Commissioners in former years. The Fisheries Department of the Board of Agriculture and Technical Instruction in Ireland.

19375. In giving a licence, do they make any examination of the site, to judge whether it is suitable or not for the purpose?—No, they do not. I am informed so. They do not take the question of possible contamination into consideration at all.

19376. (*Sir Michael Foster.*) What do they take into consideration?—Simply, if the public have no right to this particular locality that they want a licence for, and if the applicant is the owner of the land adjoining the foreshore, he gets the licence without any further question.

19377. An unlicensed laying or bed anyone can take oysters from, and anyone can put oysters down?—Quite so.

19378. (*Chairman.*) In fact, the licence or the Charter merely affects proprietary rights?—I beg your pardon.

19379. It is only proprietary rights that are affected and protected by the Charter or by the licence?—That is so.

19380. The licence or the Charter gives no guarantee that the bed or bed laying is in a satisfactory state?—That is so.

19381. (*Mr. Power.*) In regard to granting licences at the present day, is any consideration now given to sanitary considerations or pollution?—None whatever. (*Professor McWeeney.*) They are commencing now. (*Dr. Browne.*) They may be commencing. I asked that question of the Fishery Board a short time ago, and they told me they never took into consideration questions of possible contamination in granting a licence.

19382. (*Chairman.*) In point of fact, there is nothing whatever done to protect oyster beds from pollution?—Nothing.

19383. Are all forms of shellfish imported into England from Ireland?—All kinds of shellfish?

19384-5. And is the trade an increasing trade or a decreasing trade?—Well, as far as oysters are concerned, I think it is a decreasing one.

19386. Decreasing?—Since this scare has been on.

19387. That may be temporary?—Yes, that may b temporary.

19388. But up to the time of the scare was it i creasing?—Well, that I am hardly in a position answer correctly; I could not really say.

19389. It is a considerable trade?—Oh, yes, it is considerable trade. I believe, in former years—mar years ago—the output of oysters was very large indeed many times greater than at present.

19390. Well, then, I notice, and I am very please to notice, that you are of opinion that the general supe vision of the shellfish industry and the registration the shell fisheries might be entrusted to such Rive Boards as we have suggested in our former report, ac ing under a central body like the Local Governme Board; you are of opinion that those would be the be authorities?—I think they would be the best author ties certainly, but we have not in Ireland any Rive Boards.

19391. But you think that, if such an authorit could be created, that would be a good authority f the purpose?—I should say so.

19392. (*Sir Michael Foster.*) Such an authority woul naturally consult the fisheries authority?—The fisheri authority?

19393. Yes?—The central authority would consu the fisheries authority.

19394. Yes, because I mean there are two interest at stake, are there not—the fisheries and the publi health?—Yes.

19395. The Rivers Board is more a sanitary auth rity as regards public health?—Yes.

19396. The fisheries authority is to protect th fishery industries?—Yes. Well, you mean the Loca Government Board would consult the local authoritie

19397. No; that there should be some introductio of a knowledge of the fishery interests before any de cision was reached by the Rivers Board in regard t any particular laying?—Yes, I should say so.

19398. It would be sufficient, would it not, that th fishery interest should be represented on the Board?— On the Board?

19399. Or that it should be able to make representa tions to the board; that would be sufficient probably —I certainly think that they should have some mean of representing their views.

19400. Quite so, but that probably would be ade quate?—I should think so. I presume the River Board would be a fully equipped Board, in every respec able to deal with the question of inspection, and s forth.

19401. Quite so. I asked the question, because you se in England questions have arisen as to whether i should be the sanitary authority or the fishery authorit which should deal with these oysters?—Oh, I certainl think the sanitary authority—an authority having sanitary functions would be absolutely necessary.

19402. Then I gather also from what you have lai before us that this sanitary authority might issu licences?—Yes.

19403. And in issuing licences would naturally hav regard to the question of contamination?—Yes.

19404. So that within a reasonable time, at all event all licensed laying and beds might be considered a free from contamination?—All registered beds.

19405. Yes, registered beds—Yes, I suppose licensin would be done away with.

19406. Licensing would be done away with, or practically the registering would be the licensing, would i not?—Certainly that would be tantamount to it. Th registration would be a guarantee of the purity of th layings as far as it was possible to guarantee such.

19407. And possibly that would be sufficient to pr tect the public, would it not?—I should think it woul be.

19408. (*Mr. Power.*) We have a statement here wi reference to this question of controlling authority an fishery authority that it is now customary for the con trolling authority to refer any new scheme to th fishery authority for their observations. A witness is going to tell us that to-day. You are not aware o that?—I am not.

19409. I see in your report, Dr. Browne, on the various localities in which oysters and other shell fis

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are collected for market, that it is the habit to send off direct from the layings to the wholesale or retail people. Now, in this country it is very commonly the case that there are dumping places on the foreshore, very often at the mouth of a sewer, for shell fish destined for early market; but you think that does not obtain at all in Ireland?—Well, no it does not, as a rule. I should probably except periwinkles; they are collected all round the coast of Ireland, and they are sold to local dealers, small dealers, and they are bought by these small dealers in small quantities, and they are laid very often, at least, I cannot say "very often," but they are laid certainly occasionally in situations which are liable to contamination pending the collection of a sufficient quantity to forward to the English markets. And the periwinkles are brought over to England; they are not used in Ireland at all as food, neither are mussels.

19410. But you do not think that happens with regard to mussels?—Not that I am aware of.

19411. The oysters that are sent to England—to Liverpool?—There is one exception I quite forgot about; I beg your pardon, there is one place now that I remember where the oysters are bought from local fishermen by a dealer in the same way, and they are placed very near the outlet of a sewer. That place is at Belmullet, and the result of the bacterioscopic examination of these oysters proved that they were, every one, grossly polluted. Of course, they were not many yards distant from the outfall of this sewer or drain from the town of Belmullet. That is about the only case I can think of at present anyhow where the oysters are stored pending sale near sewer outfalls.

19412. It is convenient for the merchant in order to execute sudden orders to have them dumped near at hand where he can get them at all states of the tide, and within a few minutes; you do not think that is the habit in Ireland?—Sometimes these oysters—the oyster layings are usually below water mark.

19413. Quite so, they are in the channel?—It is the practice to collect them at spring tides, and put them just above ordinary low water mark so that they may be available when required in some cases.

19414. But not in the bed on the foreshore?—Oh, yes, on the foreshore, not in a bed. Those situations are not, with the exception that I have mentioned, subject to contamination in environment. From my survey of the localities I should say that there was no objection to that from a sanitary point of view.

19415. It has occurred in this country that oysters have been dredged up from perfectly satisfactory layings in the channel and for convenience put into very hazardous places on the foreshore; you do not think that is the case in Ireland?—That is not the case in Ireland.

19416. And cockles are dumped in large bulk at the mouth of a sewer, and mussels also; do you think they are equally free from such an objectionable practice in Ireland?—Yes, that practice does not obtain in Ireland, at least, as far as my information goes.

19417. I see you say, Dr. Browne: "In the case of layings, when the pollution cannot be remedied by removal, the taking of shell fish from such places direct for human consumption should be prohibited. Shell fish from such places should be laid for a specified time before sale in pure waters so as to ensure that they would be freed from any risk of communicating disease." Would you extend that to mussels and cockles; would you think it worth while to collect and relay such other shell fish, or would you be satisfied to prohibit their being taken within certain areas—definite areas?—Well, this had particular reference to oysters, this recommendation, but I certainly think that mussels might be included also. Cockles, as a rule, are not taken on the coast of Ireland from localities subject to pollution. There are some instances where they are, but in the very few instances I think they might be dealt with.

19418. By prohibition to collect them?—By prohibition to collect them. There are certain areas well known.

19419. Can you give us any rough estimate as to the mussels collected in Ireland, the proportion that are used for bait, or exported for bait, and those which go for food? Are there any data obtainable from official or other sources on that point?—I am afraid I could not give you any definite information on the subject, but I have an idea from the statements which are made to me that the largest proportions of the mussels are used for bait; the mussels collected around the northern and north-east coast of Ireland and Belfast and that direction, they are sent to Scotland for the purpose of being used for bait.

19420. There is one other point which I want to ask you about. You speak about it being necessary to close these fisheries or to prohibit the taking of oysters from them direct for consumption, as it would be impracticable to divert the sewage or subject it to such purification as would render it innocuous before being discharged into the estuaries. You regard sterilisation of sewage as hopeless from an economical point of view, do you?—Oh, I should think the expense would render it prohibitory—sterilisation—particularly with regard to the volumes of sewage from large cities and large centres of population. I should think sterilisation would be impracticable.

19421. Supposing it can be done at 20s. per 1,000,000 gallons, would you think that prohibitive?—Well, it depends altogether upon what the cost would be. Of course, in Ireland the most of these urban authorities, I am afraid, would hardly be in a position to bear the expense if it were at all heavy.

19422. That is nearly all crude sewage. I am speaking rather of an effluent than of crude sewage when I speak of 20s. per 1,000,000 gallons. Is it nearly all crude sewage there?—It is really all crude sewage which is discharged in Ireland—on the coasts of Ireland—with one or two exceptions. At Belfast they are experimenting with bacterial tanks for the bacterial treatment of sewage, but on a very small scale, and, with that exception, I think I might say that the sewage discharged on the coast of Ireland is all crude sewage.

19423. You speak again and again in your account of these localities in which oysters are grown or fattened of a map. I suppose that map will be forthcoming eventually, will it; it is difficult to follow you without it?—I am very sorry indeed that I have not got the maps. I have prepared maps showing the oyster beds and the sewer outfals all round the coast of Ireland, and these, I am sorry to say, are still in the hands of the printers, but I have got a few copies here which probably may be of some assistance to the Commission. This is Galway, for instance; these coloured patches are all oyster layings or oyster beds. *(Maps exhibited.)*

19424. The blue?—They are all different licensed beds, and out of all that series of beds this is the only one here; this is Galway town, these little round circular marks I have marked in red; this is the only oyster bed in Galway Bay that is liable to be contaminated, and the bacterioscopic examination proved I was correct. It is a public bed, and the oysters are taken from it still; there are a few, probably some thousands a year, and it is the only polluted one.

19425. It is a considerable distance to seaward?—Well, it is not; it is quite close to the docks, within about 50 yards.

19426. The dock comes down?—The dock comes down, yes. This is the coast of Galway, and this is the coast of Mayo and County Clare; it does not show it very well, that map. This will give you a general idea of the locality of the oyster bed layings. *(Map exhibited.)*

19427. Have you formed any judgment as to the way in which foreign or imported oysters ought to be dealt with on arrival in this country? Should they be dealt with on one definite plan, or would you make a difference according to the source of the oysters. Take the American oysters, for instance, which take eleven or a dozen days coming over, have you made any observation—or perhaps I should ask Professor McWeeney—as to whether they are preferable from a bacteriological point of view to those dredged out of our waters? Have they got rid of anything in the interval; are they safe to go into consumption at once, or would you relay them?—I would suggest they should all be relaid. I should also suggest that any oysters taken from any doubtful layings on our own coast should be relaid; they should not be sent to the market from a doubtful source.

19428. If you would apply that to American oysters, you would apply that to French and to Dutch, where the interval is very short?—I would. This is the form which accompanies a consignment of American oysters. *(Certificate produced.)*

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19429. (*Sir Michael Foster.*) You would not trust to that alone, I gather?—I really cannot say what amount of reliance is to be placed on that certificate, but it looks all right.

19430. (*Mr. Power.*) It gives a general testimony as to where these oysters were grown. It refers to oysters of a given class; it does not say anything about particular oysters; they may have been lying for a week or a fortnight at the mouth of a sewer for all this certificate says?—That is just what I mean; there is no knowing what may have happened to the oysters after they were taken from those beds. Pending shipment they may have been stored in some very objectionable locality.

19431. (*Sir William Ramsay.*) I was going to ask you a question on it. I notice with reference to this it states: "The regulations and ordinances of the Board of Health, which are rigidly enforced, prohibit the draining of any cesspool or closet into any running water which empties into the waters of the Great South Bay. The throwing of garbage of any kind into either the bay or water running into the same is strictly forbidden. The ordinances requiring that all closets and cesspools shall be cleaned once every month and contents removed in tight receptacles and buried over 300ft. from any water or running stream." This would appear to be very stringent, but you think, in spite of all that, these certificates are not wholly to be trusted?—Well, really that is a question I could not answer. They may be quite trustworthy, or they may be otherwise. I think it would be impossible for me to say.

19432. Do the oysters remain on the layings, such oysters as may be brought in, for periods varying from a week to six months?—Yes.

19433. These oysters are in no cases temporarily stored in tanks?—Oh, no, not at all.

19434. Never?—No, they take pretty extensive tracts of foreshore, they put the oysters down three or four deep; they take them up as they are required for the English market—that is, the American oysters. They come across packed, large consignments, closely packed in barrels without any water or any seaweed surrounding them, and they are dumped down in these beds or layings, and shovelled about and taken off as required.

19435. (*Mr. Power.*) They are gathered at all states of the tide at these layings where they are dumped down, I suppose?—No.

19436. No?—Oh, no. They extend from low water mark, I should say probably from ordinary low water mark to about half tide mark.

19437. The object being that they may be gathered by hand when they are wanted?—Yes, just when they are wanted.

19438. (*Colonel Harding.*) You spoke to us just now about the issue of licences; I suppose some fee is paid?—Well, I do not think so. I am not quite sure upon that point, but I do not think so.

19439. Then you do not know if anything is paid in the nature of rent?—Oh, I do not think so at all, and there is no rent paid as far as I am aware.

19440. (*Sir William Ramsay.*) I was going to ask that question; might I do it? Are these layings in Ireland in the hands of private individuals, or are they companies, or is the foreshore free?—I am not aware of any instance where they are owned by a company; you mean the layings?

19441. The layings, yes?—Oh, yes; there is some. Mussen and Company, of Liverpool, and Petrie and Company, they have layings in Carlingford Lough, rented from the lord of the soil, the owners of the foreshore.

19442. (*Sir Michael Foster.*) These are layings of American oysters, are they?—Yes.

19443. Exclusively American?—Exclusively American, yes.

19444. (*Mr. Power.*) And some of them are not altogether satisfactory in the way of pollution?—I am afraid not. And then, of course, there is the company, the Burreen Fishery Company, County Clare, they have beds there.

19445. (*Sir William Ramsay.*) Then are there layings that belong to individuals as there are in England?—Oh, yes, in the majority of instances; it is exceptional where they are owned by companies.

19446. Mostly by individuals?—Oh, yes.

19447. And there are what may be called free layings, where anyone can go and dredge?—No, there are very few free layings there; you mean public natural oyster beds and fisheries?

19448. Public natural oyster beds?—Oh, yes, there are several of these. Any person can go and fish in these during the open season, of course.

19449. (*Sir Michael Foster.*) You distinguish between beds and layings, do you not; beds are the natural fisheries?—I should call beds the natural fisheries.

19450. And layings where they are laid down?—Layings are where they are transferred from these natural fisheries for a certain time, probably for fattening purposes, or until they are marketable. As a rule, the natural fisheries are not good fattening grounds. The oysters when they are taken off these beds require to be relaid on more suitable layings for fattening purposes.

19451. (*Sir William Ramsay.*) Would it involve any very great hardship then if any restrictions were put on? I mean, for instance, in England we have been told in certain cases it would ruin a man's business if he were required to move his oyster laying. Would not that be said of oyster layings in Ireland?—In the case of all the natural fisheries the oysters are dredged up and sold to the owners of these private beds for the purpose of relaying and fattening. It would be no hardship as regards the public fisheries at all, but if a private owner had to take the oysters up again and relay them in some, say, pure water for a certain period, of course it would add to the expense something.

19452. Yes, but it would not ruin them?—I should think not at all. Where the public health was concerned, I should think it would be the first consideration, other interests should have a secondary place.

19453. A question has arisen as regards compensation. We will say there has been an old oyster laying, and the town has made a sewage discharge over that. If the oyster laying has to be removed the proprietor's business is practically ruined, because there is nowhere else that he can go. The question is whether the town should pay for the removal of the sewage to some safe spot, or the town should recompense the man, or the man should suffer the loss. These questions turn up. Do such questions turn up in Ireland?—Well, I should think so, in a few instances only.

19454. Very few?—Very few.

19455. (*Colonel Harding.*) Returning to the question of licences; they are revocable, are they not, under certain conditions?—Oh, yes.

19456. For instance, if within a given time the oyster bed is not properly developed; that is so, is it not?—Yes, if the oyster bed is not stocked and properly worked I believe the licence is revoked or is liable to be revoked, anyhow.

19457. Have you any knowledge whether the Departments which can revoke a licence under those circumstances cannot also revoke a licence in the event of their finding the situation is unsatisfactory from a sanitary point of view?—I believe not.

19458. They have not these powers?—So far as I am aware they have not these powers. That is the information I have got from the Department—from the heads of the Agricultural Department—that they have no power to revoke a licence on public health grounds owing to pollution.

19459. The Department of Agriculture, which exercises these powers in connection with the fisheries, does it deal generally with the fisheries in Ireland?—Yes.

19460. And you think that in the event of legislation being provided to exercise some control over oyster layings it would be better to entrust such control to a new body than to that Department of Agriculture, do you?—Well, the Department of Agriculture have no sanitary functions whatever; they are not a sanitary authority, and they could not deal properly with the question of pollution.

19461. You think it would be altogether advisable that it should be given to an *ad hoc* authority?—I certainly think so.

19462. In your experience, you have not formed the opinion, have you, at all, that sewage is beneficial to the oyster in regard to fattening?—I find the best fattening grounds are in the vicinity of sewers; at least, that was my experience going round the coast. The fattest and plumpest oysters are always to be found not very far removed from sewer outfalls.

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19463. You would not go so far as to say that it is advisable to pour sewage over oysters, in order to promote their fattening?—Well, I should think not. If it were necessary to have sewage for the purpose of fattening oysters, I think it would be better to do without oysters.

19464. You are quite conscious there is a danger, at all events in certain cases, from the presence of sewage in the neighbourhood of oysters?—Oh, I think that has been abundantly proved.

19465. But I gather you think the remedy would be rather in compelling arrangements for relaying oysters from doubtful beds than closing beds?—Oh, I should think so, because in the case of one of the natural oyster fisheries in Ireland it is one of the most productive fisheries on the coast as a spatting ground, and it, I found, was subject to pollution. This particular bed I refer to is in Tralee Bay. The crude sewage of the town of Tralee and other villages in the neighbourhood, Blemerville, is discharged within rather a short distance, probably, say, a mile or two miles—under two miles, decidedly under two miles—from the nearest point of the oyster beds. Well, it would be a serious matter to close that bed up, but, as a matter of fact, the oysters are dredged from this place for the purpose of relaying in other beds. A few may be sold, but it is very few. There are very few found in proper condition for the market when they are dredged up, and a few possibly might be sold—I mean sent direct to the market—but the vast majority of them go for relaying. I think it would be a great pity to close a bed like that; in fact, it would ruin the industry in that part of the country altogether.

19466. As to this remedy of relaying—do you think that relaying in a perfectly safe position for a month would be effective?—Well, I can only speak from what I have read on the subject. I believe that it would be, and even a shorter time. They say the oysters purge themselves of impurities in even a shorter time than a month.

19467. Then as to the practicability of this relaying?—The object of the relaying is simply to have the oysters at hand in the execution of orders, and they are placed in the immediate neighbourhood of some convenient station.

19468. (*Sir Michael Foster.*) When oysters are taken from the natural beds it is generally for the purpose of fattening?—It is always for fattening that they are taken from this particular bed. Oysters taken from these particular beds round the coast of Ireland are not fit for market. They are young brood, and in rather a poor condition. They have to be relaid in order to fit them for market.

19469. (*Colonel Harding.*) In England it is often found that oysters are laid in temporary beds for the purpose of being accessible for the delivery of orders; is that done in Ireland?—Well, only to this extent, that if the oysters are in deep water the owner of the bed simply has them dredged and brought up on the foreshore opposite where the laying or the bed is, and they are laid above low water mark, so that they may be got at when they are wanted for market.

19470. What I am anxious to get at is your opinion upon this—the practicability of this relaying. The relaying would necessarily have to be in an accessible place; that is to say, probably in the neighbourhood of a good road or a railway station; and is it not very often difficult to find a perfectly safe spot for such a relaying?—Oh, I do not think on the coast of Ireland it is at all difficult.

19471. In Ireland you think that a regulation to relay oysters for either a fortnight or a month would be a practicable thing?—The oysters from the natural beds, I may tell you, when they are relaid, it is for periods of years, probably two or three years—these oysters we are talking about from the public beds, the public fisheries.

19472. Yes, but I understand that you in your paper suggest that even from grounds which are unsatisfactory and liable to pollution, if the oysters were taken out and relaid in safe conditions for a limited period the danger would disappear?—I should say so.

19473. What I wanted was your opinion as to the practicability of carrying out such a recommendation?—I think that would be quite feasible.

19474. You think in Ireland it would be feasible?—Oh, I should think so.

19475. Without serious injury?—Without serious injury, yes.

19476. (*Chairman.*) But on that subject have you had any experience of shellfish getting freed from any risk of communicating disease?—I have not, my Lord.

19477. You do not know of your own knowledge that they do get free from disease?—Except simply, of course, from what I have learned on the subject through the reading of books, and so forth. I believe the oysters do purge themselves of impurities.

19478. (*Sir Michael Foster.*) You are referring to a set of experiments, are you not?—Yes, scientific investigations.

19479. By whom were they? Are you referring to Professor Herdmann?—Yes, I think that is the name of one. These were published in the medical papers from time to time.

19480. (*Chairman.*) You have no experience of it of your own?—No, I have no personal experience.

19481. And I see you mention the chemical examination of shellfish. Do you consider the chemical examination of shellfish shows anything as to whether they are injurious to health or not?—Well, I suppose the chemical examination would show the presence of bacilli.

19482. (*Sir Michael Foster.*) That is bacteriological?—You would find the various elements of pollution that were present, I suppose, by chemical examination, but I should depend, of course, more upon bacteriological examination and upon topographical evidence as to the situation of sewer outfalls.

19483. It is very difficult to select any chemical substance of communication?—Yes, it would be, of course.

19484. (*Chairman.*) Dr. McWeeney, you have submitted to us a report on the bacterioscopic examination of samples from shellfish layings, and I propose that this should go on the minutes of evidence?—Yes, my Lord. The report is as follows:—

* Report on the Bacterioscopic Examination of Samples taken from Shellfish Layings, by Professor E. J. McWeeney, M.A., M.D., D.P.H., Bacteriologist to the Local Government Board for Ireland.

REPORT OF BACTERIOLOGIST.

General Observations as to Methods of Examination Employed.

The material examined comprised shellfish, water, and mud or sand from the several layings. In the majority of cases the shellfish were oysters; less frequently mussels and cockles were sent. During the earlier stages of the investigation, when for any reason it seemed advisable to curtail the number of specimens, this was usually done at the expense of the mussels, as I was under the impression that these molluscs were always eaten in the cooked state, and that consequently the possibility of their contamination with sewage was of little hygienic importance. From information that came subsequently to hand, I became convinced that this was far from being the case, and that mussels are, as a matter of fact, not infrequently consumed in the raw state. During the later stages of the inquiry I therefore never failed to examine a fair proportion of the mussels when such were sent on, together with oysters and cockles, from any locality. Periwinkles are, I believe, never eaten uncooked, and accordingly I excluded these molluscs from the investigation.

The specimens were usually selected by Dr. Browne at the time of his visit, and sent packed with seaweed in cardboard boxes. They generally reached me on the morning after collection.

The specimen of water was taken usually at low tide by Dr. Browne in a sterilised, glass-stoppered, 8-ounce bottle. The mud or sand was scraped from the surface of the laying or sand-bank and sent in a wide-mouthed corked bottle of about 4 ounces capacity.

In a large number of cases I was enabled to carry out the preliminary stages of the examination on the day the samples came to hand. When, for any reason, this could not be done, the parcels were kept unopened in the ice-chest. In not more than half a dozen cases did the delay amount to more than three days, and the finding of a dead or even dying oyster or mussel in any batch of samples was a rare occurrence. The cockles appeared to be less tenacious of life, and when more than

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* *Note.*—The complete report, with plates, photographs, etc., is issued by the Local Government Board for Ireland, entitled "Report on the Shellfish Layings on the Irish Coast."

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a day had elapsed since their arrival a considerable portion were usually found to have opened.

The number of specimens examined from each laying did not vary within wide limits. I considered six molluscs, together with sand and water from each locality, as the standard quantity, and adhered to it so far as the number of specimens sent and the store of sterile substrata in readiness would permit. Before I became fully conscious of the magnitude of the task I was engaged on, I found myself, owing to lack of substrata, compelled on more than one occasion to limit the number of specimens examined from each laying to a greater extent than now seems advisable. This applies especially to certain layings in the Cork, Clare, and Galway regions. Later on, however, I made such arrangements as enabled me to cope with the standard amount of material in every case in which it came to hand, and I look forward to completing the results wherever they appear based on an insufficient number of samples. This supplementary examination will take the form of an appendix to the present report.

The object of the examination was, of course, to endeavour to determine by bacteriological methods the presence or absence of sewage contamination. In my earliest work I proceeded by means of gelatine plate cultures made with known standard quantities of material, and by the Parietti method for the demonstration of Bacillus coli. The object of the plate-cultures was to enable me to form some idea of the normal bacterial content of the molluscs both as regards number and character of germs. There was also the possibility that departures from such normal content might appear on the gelatine plates, and might be susceptible of interpretation as evidence of sewage contamination. These expectations were, however, disappointed. The germ-content of the molluscs was found to be extremely variable, the nature of the germs present in many cases (viz., rapidly liquefying the gelatine) was antagonistic to prolonged observation of the plates, and the task of identifying the colonies and constructing a bacterial flora of the three species of mollusc was utterly beyond my resources of time and available working power. By way of illustration I subjoin some photographs of plate-cultures showing the wide differences (a) in quantitative and (b) in qualitative germ-content between consecutively examined oysters from the same source. (Plate I., Figs. 1, 2, and 3.)

Accordingly I resolved in the first place to apply myself to the demonstration of the organism universally admitted to be the characteristic constituent of the bacterial flora of sewage, Bacillus coli communis, and in the second place to extend my observations to those organisms—viz., Bacillus enteritidis sporogenes (Klein) and Streptococci (Houston)—which have been suggested as test organisms in this connection, but the value of which as such appeared to me at the inception of this investigation—and, I may be permitted to add, does still appear to me—very problematical.

The investigation to which I subjected the material comprises the systematic search for B. coli communis and B. enteritidis sporogenes; with regard to Streptococci, I have not systematically sought for them, but have contented myself with recording their occurrence when I had occasion to observe it in broth tubes or on gelatine plates.

Method of Working.—Conceiving as I do that to be of practical value the results of hygienic inquiries of this kind must be based on methods not too widely different from those of every-day practice, I took no special precaution to sterilise the exterior of the oysters, etc. They were merely brushed free from mud under the tap, well rinsed with water, and opened by myself "on the flat shell." Great care was, however, taken that the instruments used were sterile, so that there could be no possibility of the conveyance of material from one mollusc to another. A large number of oyster knives and pipettes were used for each batch, and each instrument was carefully re-sterilised in the steamer before being used a second time. The shells of the oyster having been separated, the juice of the animal was allowed to flow from the flat shell on which it lay into the concave shell, and the yield was increased by making a crucial incision through the body of the mollusc with a fresh sterile knife, and, when necessary, accelerating the flow of juice by gentle pressure with the flat of the knife. From the contents of the concave shell, consisting of a mixture of sea-water and body fluid, one cubic centimetre was taken up in a sterile pipette and transferred to a ten cubic centimetre tube of sterile peptone broth, and another cubic centimetre to a tube containing ten or more cubic centimetres of freshly sterilised whole-milk. Not infrequently the oysters were large and yielded an abundance of shell water and body fluid, and in these cases larger quantities—up to three c.c.—were used for inseminating the tubes. These cases are noted in the tabulated statements. On the other hand the oysters were occasionally dry, and the small quantity of liquid available for insemination was then supplemented with a block of tissue cut from the animal itself so as to include portion of the alimentary canal. Several pairs of sterile scissors and forceps were always at hand for this purpose. It will be observed that the same oyster was, as a rule, used for the two tests. This I regard as a point of some value as throwing light upon the co-existence, or the reverse, of the two organisms sought for, in material the homogeneity of which was unquestionable. No two oysters can be regarded as homogeneous, but the mingled juice and shell water of the same oyster may, I think, be fairly regarded as such.

In the case of mussels there was usually an abundance of clear water between the shells, and no attempt was made to enrich it with body juice, as the collection of the liquid had to be quickly accomplished. Occasionally it was necessary to snip out the alimentary canal and introduce parts of it into the two culture tubes, and this had usually to be done in the case of cockles in order to provide the amount of material considered necessary.

The procedure adopted with the water was at first very simple. After shaking the bottle well, one c.c. was removed to each culture tube with a sterile pipette, and this procedure was adhered to all through when testing for B. enteritidis sporogenes. On the other hand, it seemed advisable in the case of B. coli to make some attempt to ascertain whether the demonstration might not be oftener accomplished by using larger quantities, and I accordingly adopted the plan of pipetting off 50 c.c. of the sample into a flask containing 50 c.c. sterilised distilled water, rendered nutrient by addition of 10 c.c. of a strong lactose-peptone solution and tinged blue with litmus. The object of the admixture with distilled water was, of course, to diminish the saline strength of the liquid which—especially at 37°—might have been prejudicial to the growth of B. coli. I adopted this "flask-method" rather than stone-filtration because my laboratory resources did not admit of the use of such numbers of Berkefeld-filter arrangements as were required to cope with the samples. I found it to work quite satisfactorily.

My practice as regards the mud or sand progressed on similar lines. At first I used three large loopfuls for both Coli and Enteritidis tubes. Subsequently I used rather more—sufficient to cover the point of the blade of a scalpel. When I adopted the flask-method for the water, I applied it to the mud also, rinsing out the whole contents of the sample bottle into a wide-mouthed Erlenmeyer-flask with sterile distilled water, bringing to 100 c.c. and rendering nutrient as above described. For the demonstration of Enteritidis in mud the smaller quantity was adhered to, nor was it necessary to diverge from it, as the result was almost invariably positive.

In the test for B. coli the further procedure was as follows:—At first I used to add 9 drops of Parietti's solution (hydrochloric acid 4, phenol 5, water 100), but subsequently I simplified this by adding from a sterile burette 0·3 c.c. freshly made and boiled watery solution of pure crystallised phenol (strength 5 per cent.). To the 100 c.c. flasks 3 c.c. phenol were added. The tubes or flasks were incubated at 37° for 24 hours and then examined. They were first divided into three batches, viz., those that displayed a turbidity of undoubtedly bacterial origin, those the turbidity of which might be due to the material introduced, and those that remained quite clear. The last batch was returned to the incubator for another day. The second batch was examined in the hanging drop, and those that showed bacteria were placed with the first batch, the others with the last. The first batch was then plated out in ordinary gelatine after suitable dilution to avoid overcrowding of colonies. In order to economise Petri dishes, I made use of Esmarch roll-tubes very largely at first, and subsequently I adopted the plan of ruling the bottom of the Petri dish into four quadrants, pouring in the sterile gelatine and letting it "set," and then inoculating the surface of each quadrant with a loopful or two of the dilute contents of a phenol-broth tube by means of a small camel's hair brush. I found this plan the quickest and most economical of all, and can recommend it. Instead of quadrants the Petri dish may be divided into eight segments. The one gelatine tube and Petri dish can thus be made to suffice for eight analyses.

In the flask method such of the vessels as showed change of colour from purple or blue to red, or which became decolourised, were similarly plated out. The cause of the change of colour is the fermentation of the lactose, with formation of lactic acid which reddens the litmus. Many strains of Coli go further, and reduce the litmus to a colourless leuko-product. The use of the phenol would appear to be to keep down the growth of Proteus and other liquefying germs, and I am convinced that it really does this. On the other hand, its presence may, when the material used is very poor in Coli, render the method somewhat less delicate by interfering with the development of that organism. Its omission, however, tends to favour the occurrence of pseudo-Coli species, a point which will be referred to later on.

The tubes that had not showed development at the end of 24 hours were re-examined at the end of two days, and such as contained bacteria plated out. Incubation was not pushed further, as experience showed that in 90 per cent. of the cases Coli developed within 24 hours and in the remaining 10 per cent. within 48, or not at all.

The plates were kept at 21° C., and examined daily. At this temperature Coli grows very rapidly, and the colonies are quite recognisable in 24 hours. Unless, however, the concurrence of liquefying germs threatened to destroy the plate, they were not subcultured till the second or third day. After subculture the plates were generally photographed.

The method above described is in reality one of enrichment, forcing on by artificial methods the reproduction of a relatively small number of Coli germs originally present, so that at the end of 24 hours the culture fluid comes to contain that species in overwhelming proportion. Its value may best be appreciated by glancing at the figures (Plate I., Figs. 1-4), showing the appearance of plate-cultures made direct from suspected material, and comparing them with the plates made after enrichment in phenol broth (Plate I., Figs. 6-9). In the former case we see the plate covered with most diverse colonies in large numbers, amongst which those of B. coli are discoverable with difficulty even using a powerful hand lens. Furthermore, the rapid development of the liquefying colonies destroys the plate (Plate I., Fig. 5) before the Coli colonies can attain their characteristic appearance. On the other hand, the plates made by surface brushing after enrichment and appropriate dilution show little else but Coli colonies which have ample space to attain their full size and assume their well-known appearance. Did we possess a similar enrichment method for the Typhoid Bacillus, many questions in the epidemiology of that disease that are still obscure would long since have been elucidated.

Characteristic as the appearance of B. coli on gelatine plates undoubtedly is, there can be no question as to the necessity of always verifying the diagnosis "genuine Coli" by the appropriate tests. These tests have been variously stated by various writers, and by many have, I think, been inadequately characterised. I wish to lay special stress upon the absolute necessity that every writer who concerns himself with Bacillus coli should explicitly state all the characters upon which he relies when he gives that name to a given culture. Through the neglect of this precaution much of the work that has been done upon the distribution of this organism in nature has lost its value.

The characters of every Coli-form organism isolated in the course of this investigation have been studied under the following heads:—

1. Motility;
2. Behaviour to Gram's method;
3. Appearance of the colonies on gelatine plates;
4. Power of fermenting carbohydrates;
5. Power of coagulating milk;
6. Growth on potato;
7. Power of reducing certain colouring matters; and
8. Formation of indol.

It will be necessary to say a few words on each of these points.

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1. In most books the statement will be found that B. coli is a feebly motile organism. This does not always hold good. From fæces both of suckling babies and of adults I have obtained colonies of Coli-form appearance that consisted of extremely active organisms, and were "typical" in all other respects. Furthermore, I have isolated, direct from fæces, colonies of otherwise typical Coli, the individuals of which were quite stiff, seemed spaced-out or isolated from each other in the hanging-drop, so as to lead the observer to infer the existence of an abundant mucoid sheath round each, and were perfectly motionless. I have also observed cases where the organisms were motile when grown at 18° to 21° and motionless at 37°. Many other workers have had similar experiences, *e. gr.* Stöcklin,[*] who isolated 300 strains of Coli from normal fæces, and found 184 to be more or less actively motile, whilst the other 116 were motionless. The presence or absence of motility cannot, therefore, serve as a test to distinguish genuine from pseudo-Coli.

2. None of the strains isolated retained the stain by Gram's method, and as this non-retention is common to all the Bacilli of the Coli group, it cannot be used to differentiate Coli sensu stricto from pseudo-forms.

3. On gelatine plates two forms of Coli occur—the commoner, thin, vine leaf or filmy form, and the thick, opaque, discoid form. The former usually consists of short, actively motile; the latter of longer, motionless, stiff-looking individuals. I have usually termed this the acrogenes form, on account of its resemblance to, or perhaps identity with, Escherich's Bacillus lactis acrogenes, isolated from suckling fæces. Both forms occurred very generally in material which might be regarded as heavily infected with Coli, and a colony of each kind was always subcultured and put through the tests, the result being that no constant difference could be found between the two varieties save the above-mentioned ones—appearance of the gelatine colonies and motility. The Colon Bacillus never liquefies the gelatine, and two strains which complied with the other tests, but which slowly liquefied the gelatine, had to be excluded. Similar strains have been obtained by other workers, and received special names. I have frequently had occasion to observe the production of opacity and of masses of small crystals (of ammonio-magnesian phosphate) in the gelatine, but do not regard these appearances as sufficiently constant to serve as a basis for the separation of true Coli from the outlying varieties.

4. The power of fermenting the carbohydrates is an essential part of the biology of this organism. All the strains which I studied *ad hoc* fermented glucose and maltose. Most of them fermented saccharose[†] also, though not so vigorously. In accordance with the general practice I have made lactose the test substance, using it in the form of 1 per cent. solution in agar tinted blue with litmus. The strain under examination must evolve an abundance of gas and acid when sown as a shake culture in this litmus-lactose-agar. The medium must be split up by the evolution of gas, and its original blue colour must be turned to red or discharged altogether by reduction. If these changes do not occur the organism is not classed as "genuine" Coli.

This would appear to be the proper place to refer to the evolution of gas bubbles in ordinary, *i.e.*, non-sugared gelatine, shake culture, which is looked upon by some as a test for genuine Coli. My experience is that a great many strains isolated direct from fæces do not give this "bubbling," or produce only a very few minute gas bubbles in un-sugared gelatine. At first sight the "bubbling" might appear to depend merely on the accidental presence of a small amount of fermentable carbohydrate (muscle-sugar) derived from the meat used in preparing the substratum. But the matter is not quite so simple. Lepierre[‡] found that the gas evolution occurred in absolutely carbohydrate-free gelatine, and that the evolved gases consisted of a mixture of one part of free H with two of free N (instead of CO_2 and H, as would be the case were they derived from carbohydrate fermentation). This curious phenomenon would appear, therefore, to depend on either (1) a more vigorous and complete destruction of the proteid molecule than the general behaviour of B. coli towards proteids would lead us to expect; or (2) the existence in the

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[*] Stöcklin, Becherches sur la mobilité et les Cils du Groupe des Coli-Bacilles. (Annales suisses des Sciences Medicales, Berne, 1894.)

[†] A comparative study of 16 coli-form strains undertaken at my instance by my former pupil W. MacCarthy, M.B., Travelling Scholar in Pathology of the Royal University], revealed the fact that all save one fermented saccharose broth with gas evolution varying from 44 to 2 m.m. in the fermentation tube. The broth had been previously freed from carbo-hydrate by Smith's method, and contained 2% of saccharose.

[‡] Sur less gaz produits par le Colibacille. Comptes rendus de la Soc. de biologie, 1898.

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gelatine, peptone or common salt used in making the medium, of traces of nitric acid, which is reduced by the Bacillus to nitrous acid. This may then undergo further reduction to free N, or may act upon amides or amido-acids with evolution of that gas.

Whatever be the significance of the "bubbling" to which Coli does undoubtedly sometimes give rise in genuinely carbohydrate-free gelatine shake culture, my experience leads me to state that it is not of sufficiently regular occurrence to justify its employment as a test reaction. The preparation of the medium is, furthermore, a source of difficulty and delay. On the other hand, if the bubbling be due to traces of carbohydrate in the medium, the proper course to take would undoubtedly be to regularise the presence of these traces by adding a definite quantity during the preparation of the medium. This I have done throughout the whole of the work, testing each batch of Coli-form organisms in shake culture on (1) ordinary and (2) ½ per cent. glucose gelatine. The conclusion I have come to is that the occurrence of bubbling in No. 1 is too capricious and uncertain, and in No. 2 is too invariable to be of use. By requiring bubbling to occur in ordinary gelatine we should exclude many strains that are perfectly typical in other respects. By including all that bubble glucose-gelatine we should include a great number of strains that are in other respects (*e. gr.*, effect on lactose, on milk, indol-formation) quite outside the denomination "genuine." For these reasons I do not place the "bubbling" of gelatine cultures in the category of essential tests, compliance with which must be insisted on.

5. The power of coagulating milk possessed by genuine strains of B. coli would appear to be due to acid fermentation of the lactose. This character therefore agrees with that stated in the last paragraph as regards the behaviour of the genuine Bacillus in lactose media. The coagulation must be complete, and after a few days the clot must be firm, more or less contracted, and surrounded by a clear whey. If after four days at 37° coagulation have not occurred, I do not feel justified in considering the organism to be genuine.

6. The manner in which many of these strains grew on this medium was very variable, manv otherwise typical approximating to the colourless aspect of typhoid when grown on potato. In common with others who have worked on this subject I have come to the conclusion that the character of the potato used has quite as much to do with the appearance of the culture as the character of the Bacillus, and I have not, therefore, rejected any organism which was otherwise typical, on account of its behaviour on this medium.

7. The powerful reducing effect of Coli on litmus is one of the most familiar properties of that organism. It extends to other colouring matters as well (methylene blue, sulphindigotate of soda); but the most striking changes would appear to be produced when neutral-red is used. This colouring matter, which was first introduced into bacteriology by Rothberger in 1898, has the advantage of exhibiting not merely reduction, but a superadded phenomenon, that of fluorescence, when acted upon by the Colon Bacillus. As I have never met with an otherwise typical strain isolated directly from fæces which did not comply with this test, I have made it an essential one, and required compliance with it from all strains isolated in this investigation before classing them as genuine Coli. At the same time I would not suggest that some Coli-like microbes responding feebly to this test may not, if typical in other respects, be significant of objectionable pollution. I have always used agar-shake cultures tinged with neutral-red. By this method is not infrequently evolved as well. I cannot, however, agree with the suggestion of those who would use this test for the recognition of B. coli in bacterial mixtures.* Although, according to my experience, genuine B. coli always produces the change, other organisms do so as well. I do not wish to be taken as denying all value to the test when applied directly to water or the like, but for the present at least I should not feel inclined to rely upon indications yielded by neutral-red substrata unless applied to (or suported by) pure cultivations.

8. The formation of indol in liquid media containing "peptone" is, perhaps, the best evidence we possess of the ability of the Colon Bacillus to attack Proteoses if not Proteids. The reaction for indol is a delicate one, and its success depends on the kind of culture used and the way in which the test is applied. I have always used ordinary Witte-peptone-broth cultures inoculated from the original gelatine-plate-colonies obtained when the organism was first isolated. The broth cultures were always incubated for two days at 37°, and then allowed to stand at room temperature for three weeks or a month. They were then tested with half their volume of a 20 per cent. solution of pure sulphuric acid (run in from a burette) and placed in the water bath at 60° for five minutes to see whether the pink coloration would come on, in which case the organism would appear to have formed nitrite as well as indol (assuming, of course, the Witte-peptone and H_2SO_4 to be free from nitrites). This actually did happen in about 10 per cent. of the strains, though the amount of nitrite was never large enough to produce more than a faint rose tinge. After the lapse of five minutes at 60° C., from 1 drop to ½ c.c. of a 0·02 per cent. solution of potassium nitrite was run in from a burette into the warm liquid. The effect was usually marked. An exquisitely delicate pink hue at once pervaded the fluids or formed a disc at their junction if they were not allowed to mix, and quickly deepened to an intense reddish purple. I had never seen such profound indol reactions until I adopted the above method of applying the test. Otherwise typical strains always gave the reaction to perfection, whilst it was often missed in otherwise atypical ones. Compliance with this test I have always insisted on as a fundamental character of genuine B. coli.

To sum up: the characters on the strength of which I have regarded a strain of coli-form character as genuine Coli, are the following:—

(*a.*) Character of gelatine colony and non-liquefaction of that medium even after a long time.

(*b.*) Non-retention of the stain by Gram's method.

(*c.*) Fermentation of lactose with formation of gas and acid.

(*d.*) Coagulation of milk within 4 days at 37°.

(*e.*) Production of yellowish-green fluorescence in neutral-red-agar-shake culture.

(*f.*) Production of indol in liquid peptone-media.

The accessory tests to which I have subjected all cultures, but on the result of which I do not lay principal stress, are:

(*g.*) "Bubbling" of "ordinary" and glucose-gelatine-shake cultures.

(*h.*) Growth on potato.

Lastly, on the motility of individuals, or its absence, I hesitate to lay much stress.

In conclusion, I may say that I saw no advantage from studying the pathogenicity of the very numerous strains isolated. In the case of genuine B. coli this character admittedly varies within wide limits. Nor did it seem advisable to undertake the colossal task of studying the serum reactions, more especially in view of the doubtful and contradictory results arrived at by others.

With regard to the occurrence of pseudo-Coli organisms, I have not found them of such frequent occurrence as I originally anticipated. They seemed to occur more especially in connection with certain enrichment methods. One example of this may suffice. Five oysters sent by Dr. Browne from the Public Beds, Tralee, were tested by three several methods, viz.:—

(1) The method of M'Conkey—culture in litmus-glucose-bile-salt-broth, with fermentation tube;

(2) The method suggested by Klein ("British Medical Journal," Feb. 21, 1903)—culture in litmus-lactose-peptone water, with fermentation tube; and

(3) The phenol-broth method as described above.

The fluid contents of each oyster were divided into three parts, one of which was added to a culture tube of each of the above substrata. The result was that all five oysters gave gas and acid in the Klein and M'Conkey tubes, whilst only one (No. 3) gave rise to development in the phenol-broth. All were plated out, and yielded coli-form colonies more or less mixed with liquefying ones, save in the case of the phenol-broth tube, which yielded coli-form colonies in a state of purity.

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* Cf. Makgill on the "Neutral Red Reaction as a means of detecting Baccillus Coli in Water Supplies": Savage on 'Neutral-Red in the Rontine Bacteriological Examination of Water. Jour. of Hygiene, Vol. I., No. 4.

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On further testing it was found that the coli-form organisms obtained from oysters 1, 2, 4, and 5 by the two fermentation tube methods failed to react typically in litmus-lactose-agar, neutral-red-agar, and milk, and were besides very weak formers of indol. They belonged, therefore, to the category of pseudo-Coli organisms. The coli-form organisms obtained by the phenol-broth method from oyster 3 proved to be genuine. (See photographs, Plate VI., Figs. 4, 5, 6.)

The phenol-broth is thus shown to have singled out one oyster, and justly so, whilst the seemingly positive results obtained in the case of the other four by the fermentation tube methods proved on examination to be due to organisms, the genuine character of which seems, at any rate, open to question, and which certainly lie outside of the—perhaps somewhat arbitrary—limits which I have ventured to draw.

Turning now to the demonstration of B. enteritidis sporogenes; I proceeded at first strictly along the lines laid down by Klein, the discoverer of that organism, my only departure from his method being in the direction of more complete anaerobiosis. After addition of the standard quantity of material to freshly-sterilised litmus-milk the tubes were heated in a water bath to 80° for ten minutes, and then placed in a large Novy's bottle, the air got rid of with H, connection with the atmosphere cut off, and the anaerobiosis tested by spilling a little caustic alkali on the bottom of the vessel which was strewn with pyrogallol. After two or three days' incubation the tubes were taken out and the contents of those that seemed typically changed were tested by microscopic examination and injection into animals. Furthermore, by means of dilute stroke cultures on oblique sulphindigotate-agar in a Novy bottle under H and over pyrogallol, as well as by glucose-agar plates in a Bulloch's apparatus, the organisms producing the "typical" change were isolated and their principal characters investigated. As the result of this work I find myself in agreement with Klein as regards the following points:—Large size, tendency to chain formation, bluntly-rounded ends, Gram-stainability, and variable motility of the organism; its tendency not to form spores in milk culture; its capacity for liquefying blood serum (I used Löffler's), whilst it forms an abundance of spores in that medium; its power of slowly liquefying gelatine, with ultimate formation of a clear liquid, at the bottom of which are thick white flocculi, and at the top imprisoned gas-bubbles; and its effects on guinea-pigs, which I have tested again and again with results identical with those recorded by Klein. On the other hand, I have not found it necessary to adopt anaerobic methods in order to obtain the typical enteritidis change in milk. In confirmation of this statement I submit photographs (Plate VI., Figs. 2 and 3), showing duplicate milk tubes inoculated with the same amount of material from the same oyster, etc., and incubated one under aerobic, the other under anaerobic conditions for the same length of time. A glance at the illustrations will show that the typical change has supervened quite as often under aerobic as under anaerobic conditions. Furthermore, the contents of certain of the aerobic tubes that showed the typical change were contrasted as regards their pathogenicity for guinea-pigs and found to be fully equal in this respect to the milk cultures made in the absence of air. The explanation of the growth of this obligate anaerobe without special precaution is the existence of a layer of cream on the surface of the sterile whole milk. When skim milk was used comparatively few of the tubes show the typical change. Provided, then, that fairly rich whole milk is used, I can see no advantage in adopting anaerobic methods for the demonstration of this organism, and the greater part of my results are based on the result of incubating the inoculated milk tubes without special precaution. Possibly those who advocate the test have observed the same facts, but hesitate to abandon anaerobic methods, lest by doing so some unsuspected error might arise.

I very much doubt the significance of the presence of B. enteritidis. Even when the milk tubes failed to display the change designated as typical by Klein, microscopic examination has repeatedly shown me the presence of a minority of anthrax-like, Gram-staining, non-sporing rods, evidently Enteritidis, but Enteritidis which had failed to get the upper hand owing to the prevalence of some other obligate or facultative anaerobic competitor. I have been obliged to conclude that Enteritidis is a very frequent denizen of molluscs and the sandy mud in or on which they dwell—with the exception of deep-sea beds (cf. Wicklow and Wexford results). It appears to me to be one of a number of anaerobic saprophytes, normally occurring in putrescent organic matter, whether of animal or vegetable origin (cf. Balfour Stewart's results with corn. Reports of Thomson Yates' Laboratories, Vol. III., pt. I.).

Its mere demonstration would not, therefore, appear to afford convincing evidence of fæcal contamination. On the other hand, its absence may be allowed to have a certain negative value, inasmuch as, owing to its great frequency in fæces, it could hardly be absent from material contaminated to any appreciable extent with sewage. Looking at the whole subject from the broad standpoint of the general biologist, we see that the great processes of carbon and nitrogen-circulation in nature are carried on through the agency of saprophytic organisms, mainly bacteria, some of which are anaerobic. These anaerobes may fairly be expected to occur wherever there is organic matter undergoing decomposition, that is, practically everywhere. The fact that some of them, through their toxines or otherwise, are capable of producing disease in animals into which they fortuitously obtain access, is a mere accident. The demonstration of potential pathogenicity, such as that afforded by Klein in the case of his B. enteritidis sporogenes, is no proof that the organism habitually acts in that way, or is in any sense closely or indissolubly connected with human life processes. Like tetanus, it is an anaerobic saprophyte with a rôle of its own to play in nature, though what that rôle is we do not as yet know. Like tetanus, it possesses organs of persistence (spores), which enable it to indefinitely survive any fortuitous connection it may have had with the human organism, and more especially to outlive the delicate non-sporing organisms, such as typhoid and Coli, which have undergone special differentiations to enable them to survive in the human body, and to play their part—hostile in the case of one, defensive in that of the other— in its life processes. The fact that these anaerobes form spores is therefore an important reason why they should not be used as a test of the hygienic quality of an article of diet.

How different is the case with Coli. Here we have an organism devoid of spores, and therefore endowed with very limited powers of persistence—an organism which is a habitual denizen of the alimentary canal of men and animals, and enormous numbers of which (thousands of millions of individuals) are daily produced by every human being and higher animal; an organism which has a most important rôle to play in connection with the digestive processes of the animals with which it is symbiotic—the prevention of putrefactive changes in the alimentary canal (Bienstock).* When our object is to test whether a given article of diet is contaminated with such discharges, and therefore potentially with the pathogenic forms of bacteria (typhoid, cholera) which they may contain, it is clearly to the Colon Bacillus we must look as the unmistakable index of such contamination. If we find this Bacillus present in large numbers we are justified in inferring that the contamination has been recent in point of date and fœcal in character. If the contamination has been of such old standing that the demonstration of the Colon Bacillus fails, then the more delicate pathogenic forms will *à fortiori* have also died out, and the material may be regarded with high probability as hygienically unobjectionable. If we do not find Coli, but do find the spores of B. enteritidis or other saprophyte, it is difficult to see what precise inference we can draw as to the existence or non-existence of fæcal contamination. Accordingly, while not disposed to differ from those whose experience of the test is wider and more varied than mine to the extent of denying to it all value in hygienic investigations, I cannot, in the light of my present experience, assign to it a value even approximately equal to that of the test for B. coli communis.

The gravest objection to the evidence of sewage contamination based on the bacterioscopic test is undoubtedly the ubiquity of B. coli. The fact that it invariably appears in the alimentary canal within a few hours of birth is a proof of this ubiquity, and the fact that so many billions are daily liberated from the alimentary canal of men and animals serves to explain it. Can we

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* "Untersuchungen über die Ætiologie der Eiweissfäulniss."—*Arch. f. Hyg.*, 1900. "Du Rôle des Bactéries de l'Intestin."—*Annales Pasteur*, 1900.

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fairly base conclusions on the presence of so widely distributed an organism? My opinion is that we can, provided that we do not base them on the mere presence or absence, but upon the degree of concentration of the Colon Bacillus, as was, I believe, first pointed out by Houston. Fæces afford an example of Colon bacilli aggregated in the closest manner met with in nature. And from this degree of aggregation downwards every intermediate state of concentration probably exists down to that met with in a public water supply, one or two litres of which can only supply a single Colon germ. If we can establish in the case of each article of food liable to sewage contamination a maximum standard of Coli-content—as has been so brilliantly attempted by Houston in the case of sewage effluents—we shall have done all that can fairly be demanded of bacteriology, unless, indeed, further researches show that fæces contain some still more characteristic organism (such as B. acidophilus, recently found by Moro* in the fæces of sucklings), which is not liable to occur elsewhere.

The question arises whether the work which I have now the honour to submit to the Local Government Board does really supply such a standard. Confident as I am of its accuracy, so far as it goes, I am not prepared to assert that it does this. It tells of the presence or absence of the Colon Bacillus in 1 c.c. of oyster contents; it tends to show that the Bacillus is absent from 1 c.c. of fluid when the oyster comes from uncontaminated sources, and that when the Bacillus is present in several oysters from the same source, that source is usually open to grave suspicion on other grounds. In order to thoroughly solve the problem it would be necessary—

(1.) To ascertain whether oysters, etc., which do not contain the Colon Bacillus in 1 c.c. can be shown to contain it in their entire organism;

(2.) Whether the Colon Bacillus is ever demonstrable in small quantities (1, 10, or 100 c.c.) of sea-water taken far from the shore, and therefore absolutely free from all possibility of contamination with sewage; and

(3.) Whether there exist in the sea-water of oyster beds sources of B. coli (sensu stricto) other than sewage. I refer to the possibility that the intestinal contents of sea-fowl and fish may contain that organism, and, under certain circumstances, liberate it into the water in quantities large enough to perceptibly affect its bacteriological character.

If oysters that do not contain B. coli in 1 c.c. juice are found free from it altogether, then there can be no doubt that this amount will really form a convenient standard quantity from which the Colon Bacillus must be absent in hygienically unobjectionable molluscs.

If it can be shown that the Colon Bacillus does not occur in, say, 100 c.c. of open sea-water, then its occurrence in, say, 1 c.c. of water from an oyster bed must surely be held to justify condemnation of that water as contaminated with Colon Bacillus containing material—in other words with sewage—provided that the other possible sources of Coli, referred to in paragraph 3 above, are shown to be practically non-existent.

It is to these points that I propose to turn my attention in any subsequent work which the Local Government Board may see fit to entrust to me on this subject.

In conclusion, I would draw attention to the fact that in preparing the bacterioscopic reports which I have now the honour to submit, I have been not only uninfluenced by any local knowledge, but—with the exception of Dublin Bay and vicinity—absolutely ignorant of the local conditions. With the results of Dr. Browne's inspection of the several localities I have never become acquainted till after the bacterioscopic report was completed and sent in. I cannot but regard it as highly satisfactory, from the point of view of bacteriology, that the conclusions arrived at by Drs. Browne and Edgar Flinn, Medical Inspectors to the Local Government Board, as the result of examination of the several localities, have in so many cases been in agreement with the results to which I have been led by independent laboratory investigation.

Finally, I beg to submit the following extracts from my Regional Reports as showing how accurately the bacterioscopic results represent the degree of sewage contamination ascertainable by local inspection.

E. J. McWeeney.

18th August, 1903.

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* Jahrb. f. Kinderheilk. 1900.

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*Extracts from Regional Reports.**

Coast of County of Clare.

The two oyster-beds near Burren in this County yielded—in complete accordance with their well-known character—totally negative results both for *Coli* and *Enteritidis*.

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
I. Mr. Mannix's Beds, Burren, County Clare. (10–4–03).				
Oysters No. 1	–	Phenol-broth sterile	–	No change.
,, No. 2	–	,, ,,	–	,,
,, No. 3	–	,, ,,	–	,,
,, No. 4	–	,, ,,	–	,,
,, No. 5	–	,, ,,	–	,,
,, No. 6	–	,, ,,	–	Litmus milk bleached below
Water from same place	–	,, ,,	–	No change.
Mud ,, ,,	–	,, ,,	–	,,
II. "Red Bank" Layings, Burren, County Clare. (31–3–03).				
Oyster No. 1	–		–	Milk unchanged
,, No. 2	–		–	
,, No. 3	–	This Oyster tested by both the Klein and the M'Conkey methods as well as by the Phenol-broth: negative results with all.		Not examined for enteritidis.
,, No. 4	–			
Water from same place	–		–	Milk unchanged.
Mud ,, ,,	–		–	

+ signifies that the organism tested for was found.
— signifies that the organism was not found.

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* "Report on the Shellfish Layings on the Irish Coast," issued by the Local Government Board for Ireland.

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Coast of County of Galway.

Material was sent from eighteen localities on the extensive seaboard of this country, and it will be noticed that the results of the examination were almost completely negative as regards *Coli*, save in one locality, viz., the Quay Galway. The results column of the tabulated statement subjoined would appear to suggest that the layings in question are in close proximity to a sewer outfall.

I cannot account for the presence of *pseudo-Coli* at Pollagh and Mulroog. It will be noted that the *Enteritidis* also occurs much less frequently than usual, and, curiously enough, it would appear to have been absent from the oysters and mussels at Galway Quay. This may probably be accounted for by the fact that the number examined *ad hoc* was not sufficiently large.

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
I. Layings at Crushena Kinvara Bay. (Public Beds). (2–4–03).				
Oyster No. 1 - - - -	–	No development in any of these broth tubes.	?	Change atypical, but tube contained Gram-staining Bacilli resembling *Enteritidis*.
,, No. 2 - - - -	–		–	No typical change in any of these.
,, No. 3 - - - -	–		–	
Water from same place - -	–		–	
Mud ,, ,, - -	–		–	
II. Layings at Clarenbridge, County Galway. (Messrs. Neilan and Lenehan's). (26–3–03).		Medium-sized fairly plump Oysters.		
Oyster No. 1 - - - -	–	Phenol-broth tube failed to develop.	–	
,, No. 2 - - - -	–	,, ,, ,,	–	
,, No. 3 - - - -	–	,, ,, ,,		Not examined.
Sea-water from same place - -	–	50 c.c. tested by addition of lactose-peptone-litmus mixture.	–	Milk unaltered (1 c.c. sample used.)
Mud ,, ,, - -	–	About 20 c.c. washings of entire specimen tested.	–	3 large loopfuls used.
III. Layings at Clarenbridge, Galway Bay. (Public Beds). (26–3–03).				
Oyster No. 1 - - - -	–	Same remarks as in case of last group.	–	
,, No. 2 - - - -	–	,, ,, ,,	–	This milk tube inoculated with a mixture of the juices of Oysters 2 and 3 – amount used, 1·1 c.c.
,, No. 3 - - - -	–	,, ,, ,,		
Sea-water from same place - -	–	50 c.c. tested as in case of last group.	–	–
Mud ,, ,, - -	–	Only cocci on plate - - -	+	On microscopical examination typical Gram staining rods.

+ signifies that the organism tested for was found.
– signifies that the organism was not found.

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Coast of County of Galway—*continued.*

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
IV. Layings at Clarenbridge, Galway Bay. (Tyrone Beds). (26-3-03).				
Oyster No. 1 - - - -	–		–	
,, No. 2 - - - -	–	Coli-form organism—atypical in several respects.	–	
,, No. 3 - - - -	–			Not examined.
Sea-water from same place - -	–		–	Milk unchanged.
Mud ,, ,, - -	–	Sporing anaerobes grew in broth. Nothing resembling coli on plate.	+	Typical Gram-staining rods pure.
V. Layings at Renville, Oranmore Bay. (Dr. W. P. Kirwan). (31-3-03.)				
Oyster No. 1 - - - -	–	None of the phenol-broth tubes showed development.	–	No change in either.
,, No. 2 - - - -	–		–	
,, No. 3 - - - -	–			Not examined.
Water from same place - -	–	Development in broth, but plating out yielded nothing.	–	
Mud ,, ,, - - -	–	,, ,, ,, ,,	+	Typical result.
VI. Layings at Ardfry, Oranmore, Co. Galway. (New Harbour). (26-3-03.)				
Oyster No. 1 - - - -	–	The phenol-broth showed development, but the plate made from it remained sterile? Anaerobes.	+	Typical Gram-staining rods.
,, No. 2 - - - -	–	Phenol-broth sterile.	–	Milk unchanged.
,, No. 3 - - - -	–			Not examined.
Sea-water from same place - -	–		–	
Mud ,, ,, - -	–	Broth became turbid, but the plate was sterile? Anaerobes.	+	Typical Gram-staining rods.
VII. Layings close to Quay, Galway. (Public Bed.) (27-3-03.)				
Oyster No. 1 - - - -	+	Typical coli, resembling typhoid in its growth on potato, isolated.	–	
,, No. 2 - - - -	–	Phenol-broth gave no growth.	–	
,, No. 3 - - - -	+	Undoubted coli, though a little weak as an indol former.		Not examined.
Mussel No. 1 - - - -	+	Absolutely typical coli obtained.	–	
,, No. 2 - - - -	–	The phenol-bouillon gave growth, but nothing grew on the plate—anaerobes.	–	Litmus milk bleached, but neither coagulation or gas-formation.
Water from same place - -	–		+	Typical Gram-staining rods.
Mud ,, ,, - -	–		+	Took a day longer incubation before + result certain.
VIII. Layings at Cashel Bay, Co. Galway. (Mr. Berridge's.) (30-3-03.)				
Oyster No. 1 - - -	–	All three phenol-broth tubes remained sterile. Only ·8 c.c. juice obtained from No. 2.	+	Typical Gram-staining rods.
,, No. 2 - - - -	–			
,, No. 3 - - - -	–			
,, No. 4 - - - -		Not examined for coli	+	The entire juice of these two oysters used for the enteritid's test. Typical result.
,, No. 5 - - - -		,, ,, ,,		
Water from same place - -	–	Phenol broth gave no growth.	–	
Mud ,, ,, - - -	–	,, ,, ,,	+	Took a day longer incubation to obtain + result.

+ signifies that the organism tested for was found.
– signifies that the organism was not found.

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Coast of County of Galway—*continued.*

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
IX. Layings at Cashel Bay, Co. Galway. — "The Pond." (Mr. Berridge's). (30–3–03).				
Oyster No. 1 - - - - -	–	None of the phenol-broth tubes showed development.	–	No change in either.
,, No. 2 - - - - -	–		–	
,, No. 3 - - - - -	–			Not examined.
X. Mr. W. Evans Jackson's Layings in Mannin Bay. (29–4–03).				
Oyster No. 1 - - - - -	–	Phenol-broth sterile - - -	–	No change.
,, No. 2 - - - - -	–	Strepto cocci in broth - -	–	Bleached below.
,, No. 3 - - - - -	–	Phenol-broth sterile - - -	–	,, ,,
Water from same place - -	+	Typhoid-like growth on potato -	–	Result atypical.
Mud ,, ,, - -	–	Phenol-broth sterile - - -	+	Typical change.
XI. Layings at South Faul, Ardbear Bay, Co. Galway. (Mr. Jackson's). (31–3–03).				
Oyster No. 1, so-called "Marketable Oyster."	–		–	Milk unchanged.
,, No. 2 do.	–		–	
,, No. 3 - - - - -	–			Not examined.
,, No. 4 - - - - -	–	This Oyster (No. 4) tested by Klein and M'Conkey methods as well as by phenol-broth. The M'Conkey method yielded a coli-form organism rejected for non-compliance with milk, indol, and potato tests.		
Water from same place - -	–			
Mud ,, ,, - -	–	Sporing anaerobes developed in broth.	+	Typical Gram-staining rods.
XII. Layings at North Faul, Clifden Bay (Mr. Jackson's). (31–3–03). So-called "Growing Beds."				
Oyster No. 1 - - - - -	–	Phenol-broth sterile - -	–	Milk unchanged.
,, No. 2 - - - - -	–	,, ,, - - -	–	
,, No. 3 - - - - -	–	,, ,, - - -		Not examined.
,, No. 4 - - - - -	–	,, ,, - - -		
Water from same place - -	–	,, ,, - - -		
Mud ,, ,, - -	–	,, ,, - - -	+	Typical Gram-staining rods.
XIII. Layings at Ballinakill Bay, Co. Galway. (Atlantic Oyster Co.). (1–4–03).				
Oyster No. 1 - - - - -	–	No development in any of the phenol-broth tubes.	+	One milk tube out of 2 inoculated from this oyster showed typical changes.
,, No. 2 - - - - -	–		–	Milk unchanged.
,, No. 3 - - - - -	–			Not examined.
,, No. 4 - - - - -	–			
Water from same place - -	–		–	Milk unchanged.
Mud ,, ,, - -	–		+	Typical change.

+ signifies that the organism tested for was found.
– signifies that the organism was not found.

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Coast of County of Galway—*continued.*

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
XIV. Layings at Ballinakill, Fahy Bay, Co. Galway, so-called "Public Beds." (1-4-03).				
Oyster (the only one sent) - -	–		–	One of two duplicates became bleached, but no typical change.
Water from same place - -	–		–	
Mud ,, ,, - -	–	Development in broth, but nothing on plate. Anaerobes.	+	Typical change.
XV. Layings at Dawros Beg, Ballinakill Bay (Atlantic Oyster Co.) (2-4-03).				
Oyster No. 1 } All that were sent.	–	No growth in any of these phenol-broth tubes.	–	
,, No. 2	–		–	
,, No. 3	–		+	Typical change in one of two tubes inoculated from this oyster.
Water from same place - -	–		–	
Mud ,, ,, - - -	–		+	Typical change came on rather slowly.
XVI. Layings at Barnaderg Bay, Letterfrack (Mitchell Henry's). (2-4-03).				
Oyster No. 1 } All that were sent.	–	No development in any of these broth tubes.	–	No typical change in any of these milk tubes.
,, No. 2	–		–	
,, No. 3	–		–	
Water from same place - -	–		–	
Mud ,, ,, - -	–		+	Typical change.
XVII. Layings at Pollagh and Mulroog (Mr. St. George). (3-4-03).				
Oyster No. 1 - - - -	? –	Typical coli, save that it formed no indol.	+	Interesting to note that these were the two oysters that yielded the coli-form organisms.
,, No. 2 - - - -	? –	Coli-form rejected on several tests.	+	
,, No. 3 - - - -	–	Broth yielded no growth - -	–	
Water from same place - -	–		–	
Mud ,, ,, - -	–	Growth in broth, but ? anaerobes only.	+	
XVIII. Layings at Leenane, Killary Bay (Mussels only).				
Mussel No. 1 - - - -	–		–	Not examined for enteritidis.
,, No. 2 - - - -	–		–	
Water from same place - -	–		–	
Mud ,, ,, - -	–	Cocci developed in the phenol-broth.	+	Typical change.
Mussel No. 3 - - - -	–		–	Changes in both milk tubes but not typical.
,, No. 4 - - - -	–		–	

+ signifies that the organism tested for was found.
– signifies that the organism was not found.

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COAST OF COUNTY OF DUBLIN.

Dublin Bay and Vicinity.

My first visit to the Clontarf layings was made in company with Dr. Edgar Flinn on January 22nd, 1903. The first samples we collected on that occasion were two American "Blue-point" oysters, which had lain some months on the beds, and were amongst those in the act of being removed on a cart for disposal through the usual channels. In dealing with these and the other samples collected on the same occasion, the examination made took the form of ascertaining the numerical germ-content of the mingled oyster-juice and shell-water, whilst the characters of the several colonies that developed on the plates were carefully noted. B. coli was also tested for in each case by the phenol-broth method. The result of the plate cultures made from these two oysters was closely accordant, corresponding to a germ-content of about 10,000 germs per cubic centimetre of fluid. The largest colonies on each plate were, as usual, in such specimens, of the Proteus and Fluorescens type. The minuter colonies were mostly cocci. The plates also showed some doubtfully coli-form colonies which were not subcultured, as the phenol-broth method had already yielded positive results. The general aspect of the plate-cultures was strongly suggestive of sewage, as may be seen from photograph (Plate I., fig. 4). The phenol-broth tube made from each oyster gave positive results, typical B. coli, forming colonies of vine-leaf (preferably termed "filmy") pattern, being isolated therefrom and complying with the necessary tests.

The second group of samples comprised six "East River" oysters, laid down two months previously. Two of these were used for plate-culture, and four for phenol-broth tubes.

Oyster 1.—Germ-content 2,000 per c.c., about one-tenth of which were large liquefying colonies. There were typical coli-form colonies also on the plate.

Oyster 2.—Here the colonies were fewer, working out at about 1,000 per c.c., but the character of most of them was pronouncedly liquefying, so that they rapidly became confluent, and destroyed the plate. Before this occurred, however, it was possible to detect and subculture several small coli-form colonies of aerogenes type. The appearance of this plate, when four days old, is reproduced on Plate I., fig. 5.

Oyster 3.—From this and the following specimens only the phenol-broth tube was done. It yielded coli-form colonies of filmy texture (which proved to be genuine), together with some more opaque, discoid, not fringed, and therefore quite suggestive of aerogenes, were it not that they gradually liquefied the gelatine. This property would be regarded by most workers as at once justifying their removal from the denomination B. coli. In their luxuriant growth on phenolated-broth, as well as in their behaviour towards the several sugars, potato, milk, neutral red, and in their abundant formation of indol, the colonies agreed with the typical Colon bacillus, and one would be inclined to suggest for this organism the name B. coli liquefaciens. Similar organisms have been encountered by Dr. Klein.

Oysters 4, 5, and 6 yielded typical coli-form colonies of either or both types, which stood the tests and were shown to be genuine Coli.

Group 3.—"East Rivers," laid down 10 months previously. Six of these were collected, of which two were used for plates and the other four tested by the phenol-broth method. The result did not materially differ from that arrived at in the case of the last group. The germ-content was found to be about 1,000 and 1,500 respectively, whilst coli-form colonies appeared on both plates, and were obtained from all the phenol-broth tubes.

Group 4 consisted of a few living specimens picked by ourselves out of a great accumulation of dead oysters and shells on the Clontarf foreshore, close to the layings. Five of these were tested. The germ-content of two of them was found to be approximately 3,000 per c.c. The appearance of the plates was slightly different from that of the previous samples, owing to the presence of colonies of a common mould (Mucor), and of a peculiar cloudy colony resembling those described by Frankland as B. nubilus. All these specimens yielded B. coli.

Group 5.—This consisted of four oysters from the most inland part of the layings, and therefore nearest to the sewer outfalls.

Specimens 1 and 2 were plated out and yielded about 2,000 colonies per c.c., including the ordinary saprophytes together with coli-form colonies. The other two yielded genuine Coli on being tested by the phenol broth method.

Group 6 comprised three oysters from a point still further inland than that at which Group 5 was taken, and quite beyond the confines of the layings. They were old specimens that had been a long time laid down—some three years, as we were assured in the case of No. 1, which was a very large, thick-shelled oyster. They had reached their present position through being washed up during gales. How long they had been there it was impossible to say.

Oyster 1—the very large specimen—proved to have a germ-content of about 1,000 per c.c. The plate bore a large and beautiful colony of B. figurans. Coli-form colonies were present, but fewer than in most of the previous plates. Oysters 2 and 3 yielded genuine B. coli by the phenol-broth method.

Group 7 comprised six cockles found lying on the surface of the foreshore, within a few yards of a sewer outfall, but not in a line with it. How they came to be above the surface of the sand is not clear. I am not aware that these molluscs are liable to be brought to the surface by storms. Possibly they may have been dropped there by some cockle merchant, or been gathered by a child and thrown away again. One of them was plated out and found to contain approximately 1,000 germs per cubic centimetre of body fluid. Quite a large proportion of these was typically coli-form, and one of them was found to stand the tests. The four remaining cockles were tested by the phenol-broth method, but only one of them—No. 3—yielded Coli. The others failed to give rise to turbidity in the broth—possibly because the quantity of material available for inoculating them was too small (a few drops), possibly because they had come from less contaminated surroundings.

The results in the above series were controlled by a parallel series of cultures, made both on gelatine plates and in Parietti tubes, from a sample of tap water, artificially infected with a loopful of putrescent human fæces. The coli-form colonies that appeared on the original plates and on those obtained by plating out the turbid phenol-broth tubes were carefully compared with those obtained from the oysters by identical methods, and their close similarity established beyond a doubt. Some strains of Coli, isolated from the fæces, were put through the several confirmatory tests at the same time as those derived from the shellfish, and their behaviour found to be identical.

The remarkable uniformity of these results—if we leave the cockles out of consideration for a moment—led me to form the opinion that the molluscs on these layings were subject to profound and widespread contamination with matters of excretal origin, and having in the meantime convinced myself by the examination of several batches of oysters from layings along the West Coast, procured by myself from merchants in the city, that the Colon bacillus is not a normal inhabitant of the oyster, I thought it my duty to make an *ad interim* report to the Local Government Board, in the hope that steps might be taken to safeguard the public from a possible source of danger. What took place has been already stated. The subject attracted considerable attention at the time, and I understand that the lessees of the layings were notified that their occupancy would have to terminate. Whether the practice of fattening oysters on these gravely polluted layings has actually been discontinued I do not know.

In the subsequent examinations of material from the shores of Dublin Bay, I modified the procedure in the following points:—

1. By omitting the gelatine plate culture of the oyster fluid—the utility of this, from the special point of view of the analysis, being very doubtful;
2. By adding the test for B. enteritidis sporogenes (Klein); and
3. By the introduction, in a few instances, of a quantitative test for the organisms in question.

In accordance with this plan, I examined the following materials collected by myself, conjointly with Dr. Edgar Flinn, during a visit which we paid to the layings on April 10th, 1903.

Group 1.—Very large coarse oysters, of the description known as "North Sea" oysters (three collected).

Group 2.—Rather small oysters, described as "from Cork" (three collected).

Group 3.—Medium-sized oysters, described as "Carlingfords" (three collected). Immediately after arrival

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at the laboratory, and within two hours of collection, the largest of the three oysters comprising each group was selected, opened with the usual precautions, and all that could be obtained of the body juices and shell water transferred to a sterile test tube, and well mixed by shaking. With this fluid a series of dilutions in phenolated broth were prepared, so that the first tube received 1 c.c. of the liquid, the second 0·1 c.c., the third 0·01 c.c., the fourth 0·001 c.c., and the fifth 0·0001 c.c. The only variant in each tube was the amount of oyster fluid, the total bulk of liquid, and the percentage of phenol remaining the same. All were put away at 37° C.

Next day the first two tubes of the "North-East" series, the first two of the "Cork" series, and the first three of the "Carlingford" series showed development. After two days had elapsed the third of the "North Sea" series became turbid. None of the others underwent change, though observed for several days. On plating out the turbid broth tubes, the 1 c.c. tube of the "North Sea" series yielded coli-form colonies of typical filmy and also of aerogenes pattern. The 0·1 c.c. tube yielded the filmy variety only, whilst the 0·01 c.c. tube yielded the aerogenes variety in a pure state. On each plate were some colonies of cocci. (See Plate I., Fig. 6, A, B, and C.)

The 1 c.c. and 0·1 c.c. tubes of the "Cork" oyster series yielded typical coli-form colonies of the filmy pattern, intermixed, in the case of the former, with coccus colonies, absolutely pure in the case of the latter (Plate I., Fig. 7, G). The former also produced a large liquefying colony which was threatening to destroy the whole plate at the time the photograph was taken (Plate I., Fig. 6, F).

The first three tubes of the "Carlingford" oyster series also yielded coli-form colonies on the plates, as may be seen by referring to Plate I., Fig. 7, where K shows the result of plating-out the 1 c.c., L the 0·1 c.c., and M the 0·01 c.c. tube respectively. K and L show coli-form colonies of the filmy type, and M colonies of the aerogenes variety. The colony selected for sub-culture may be recognised by the track of the inoculating needle.

From the above experiment it would appear that the "North Sea" and "Carlingford" oysters examined, contained in each cubic centimetre of their mingled body-juice and shell-water, at least 100 and less than 1,000 living germs of Bacillus coli, whilst in the "Cork" oyster the number present per cubic centimetre was at least ten, but less than 100 individuals of Coli. It would have been interesting, and, perhaps, useful, to have applied the quantitative method to a large number of specimens from different sources; but on account of the very large number of specimens sent in at once, this could not be undertaken.

The two remaining oysters of each group were tested as usual, 1 c.c. of mingled juice and shell-water being operated on. All six yielded positive results. The two "North Sea" oysters gave the result reproduced on Plate I., fig. 8, A1 and A2. The former bears coli-form colonies of the aerogenes type, together with one large colony of filmy pattern, in which the track of the sub-culture-needle can be seen. In the latter, A2, the colonies are of the filmy pattern, and exhibit a progressive increase in size from the centre towards the periphery, where there is more space, and the layer of gelatine is deeper. The one selected for sub-culture and study can be recognised by the needle-mark. It lies at the periphery, and is the next colony but one, below the left-hand end of the horizontal diameter. Minute coccus colonies appear on both plates. In the case of the two remaining so-called "Cork" oysters, the results of plating-out the turbid phenol-broth tubes can be seen in Plate I., fig. 9, B1 and B2; whilst the results in the case of the two remaining "Carlingford" oysters are in the same figure (C1 and C2). The two former present a mixture in varying proportions of two varieties, "filmy" and "aerogenes" of Coli, whilst in the two latter the filmy variety is alone represented, intermixed with a few minute coccus colonies.

All nine oysters collected on this occasion were thus shown to contain B. coli communis.

Turning now to the presence of B. enteritidis sporogenes, quantitative tests were applied to the same three oysters as in the case of B. coli; owing, however, to an unfortunate omission in writing up the notes, I am not in a position to make any statement of results further than that the first (1·0 c.c.) tube of each series displayed the typical change. The two remaining oysters of each group were also tested for this organism as usual, and the results need not be detailed in this place; they will be found in the tabulated statement.

On the same occasion, samples of the water and ground formation of the Clontarf layings were collected. Water No. 1 was collected from a clean-looking pool that had been left in the middle of the layings by the receding tide. Sample No. 2 was taken at the furthest point of the layings that could be reached dry-shod, where the returning tide was beginning to submerge them. The water here was dirty-looking, with patches of a thin greyish scum floating on the surface. The current was not advancing from the direction of the open sea, but from the westerly direction, that is, from the mouth of the Liffey. To both of these samples of water the quantitative method was applied, the dilutions ranging from 1·0 to 0·0001 c.c. In the case of Sample 1, the result was doubtful, some disturbing element having evidently entered into the experiment. After one day in the incubator, all the five broth-tubes remained clear. At the end of the second day the first and third tubes, containing respectively 1·0 and 0·01 c.c. sample, showed development, but not the intervening (0·1 c.c.) one. The result of plating out the 1·0 c.c. tube is seen on Plate I., fig. 9, at W1a. It yielded no coli-form colonies, only cocci. In the case of the 0·01 c.c. tube, the result of plating-out which is seen on the same figure at W1c, the preliminary dilution has evidently been pushed too far. Only three colonies of different sizes and characters appear on the plate. The largest was very doubtfully coli-form. It was sub-cultured, as may be seen from the needle-mark, and behaved typically on some of the test-media, but its growth in milk and neutral-red-agar-shake precluded its being ranked with genuine Coli. This water must, therefore, be passed as free from Coli in 1 c.c. The result in the case of Sample 2 was very different. The first two tubes of its series became turbid, and on being plated-out, produced the appearance seen in the illustration (Plate I., fig. 9, W2a and W2b), which shows exquisitely filmy coli-form colonies of bizarre shapes. It would therefore appear that whereas the water taken from a pool in the middle of the layings was not shown to contain Coli, the incoming tide would appear to have been, on the occasion of the examination at any rate, carrying with it individuals of that species to the number of at least 10, but less than 100, per cubic centimetre.

The result as regards B. enteritidis sporogenes was negative in the case of both water samples. Dilutions varying from 1·0 to 0·0001 c.c. were made of both. The higher dilutions underwent no change. The 1·0 and 0·1 c.c. tubes became bleached, and exhaled an unpleasant odour, but failed to assume the appearance characteristic of B. enteritidis.

A sample of mud was also collected from the surface of the oyster bed. It was black in colour, and smelt abominably. To 100 c.c. of sterile water 10 grammes of this mud was added and thoroughly shaken up. Dilutions were then established, containing from 1·0 c.c. to 0·0001 c.c. of this suspension, and corresponding to from 0·1 to 0·0001 gr. of the mud. The result was that the two first tubes alone showed development, and yielded, on plating-out, liquefying colonies and cocci in the case of the 1·0 c.c. tube, and in that of the 0·1 c.c. tube coccus colonies only (see Plate I., fig. 8, M1 and M2). This result shows either that there was no Coli in the quantity taken of the mud, or (which I am inclined to think is more probable) that Coli fails to maintain itself in the presence of certain intensely putrefactive organisms. The phenol-broth tubes exhaled an appalling stench.

Nor were the results of the enteritidis test very striking when applied to this mud. Only the lowest dilution responded with typical results, and it would therefore appear that this very foul material was not found to contain any germs of Coli, and to contain less than 100 germs of enteritidis per gramme. I think it highly desirable that similar specimens of foul-smelling mud should be repeatedly examined by more than one method for the detection of B. coli.

On May 4th, 1903, accompanied by Dr. T. J. Browne (medical inspector, Local Government Board), I visited the layings at Sutton, on the northern shore of Dublin Bay, and abutting on the promontory of Howth. The following samples were collected:—Six "American Blue-point" oysters, one "Portuguese" oyster, water, and sandy mud from the beds.

Not one of the seven oysters was found to contain B. coli (one harboured a pseudo-coli species), nor could it be detected in the water or mud, which was clean and sandy.

The same samples were also subjected to the enteritidis test, with the following result:—Oysters 2, 4, 5, and 6 ("American Blue-points"), as well as the Portuguese oysters, and the sand and water, gave the typical change in litmus milk.

These results do not, in my opinion, justify any positive conclusion as to the presence or possibility of sewage-

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contamination of the layings at Sutton. It would be necessary, before making a definite statement on this point, to examine a larger number of samples, and to take them at a season when the neighbouring houses contained their summer population, which was not the case at the time of our visit.*

On May 9th, in company with Dr. Edgar Flinn, I visited the southern shore of Dublin Bay, and collected the following specimens:—

Group 1.—Six cockles, from a point about 60 yards from high water mark, and about 50 yards to the west of Merrion Gates.

Group 2.—Six cockles from further out—some 400 yards below high water mark.

Group 3.—Six cockles from the furthest point that could be reached dryshod about mid-way between Merrion and Booterstown Stations. The distance from the mainland I estimated at about 900 yards.

Water was also collected from the returning tide at this extreme point, and a sample of mud was collected from a clean-looking spot opposite Merrion Gates, and about 350 yards from the railway embankment.

Details as to quantities of material used will be found in the tabulated statement, and the outcome of the examination may be summarised as follows:—

Taking the Coli results first—three of the six cockles in Group 1, five of those in Group 2, and four of those in Group 3 yielded a positive result, whereas both water and mud were totally negative, although unusually large quantities were operated on. As regards enteritidis, all the 18 cockles, with the exception of one from Group 3, evoked the typical change in milk. The mud gave the test, but not the water.

The shell fish (cockles) from Sandymount Strand would, therefore, appear to have been extensively contaminated with sewage on the occasion of my visit.

My next examination of material from the shores of Dublin Bay took place ten days later, on the 19th May, when Dr. Edgar Flinn handed me samples of cockles collected by him at Clontarf a couple of hours previously.

The first group of these was taken on the strand opposite Victoria Terrace. It consisted of six cockles, each of which I tested for Coli and enteritidis, with the result that Coli was found in all, and enteritidis in all but one (No. 4), which changed the milk atypically.

The second group consisted of six cockles collected by Dr. Flinn on the strand opposite "Watson's House," at Clontarf. Certain of these cockles contained putrefactive organisms of abnormally vigorous growth at blood-heat, and caused the phenol-broth tubes inoculated from them to become unusually turbid—I refer, of course, to the culture fluid—and to admit a nauseating odour of putrefaction. The plates made from these two tubes exhibited only liquefying organisms, whilst those made from the four other broth-tubes, in which the putrid form of decomposition was not so well marked, yielded typical coli-form colonies. All six were found to contain B. enteritidis sporogenes.

On May 25th Dr. Flinn collected and brought to me six cockles from the strand at Irishtown, taken at a point midway between the mainland and the New Isolation Hospital at the "Pigeon House." Two of the six proved to contain B. Coli, three gave rise to coccus colonies only, whilst the sixth produced a turbidity in the phenolated broth, which was found on microscopic examination to be caused by the presence of innumerable ciliated cells, evidently derived from the branchial epithelium of the mollusc. All six yielded B. enteritidis.

On the 11th June, 1903, Dr. Flinn brought to the laboratory nine mussels from the strand at Blackrock (south shore of Dublin Bay), to the east of Sandymount. Eight of the nine yielded typical Coli, the colonies on the plates partaking of both the filmy and the aerogenes or discoid character. The exception (No. 8) yielded a plate which was precisely similar to the others, and which might have been passed without hesitation as covered with Coli colonies. In accordance with the invariable rule which I have followed throughout the investigation, of subjecting at least one coli-form colony on each plate to sub-culture and subsequent testing, I re-inoculated two colonies, one filmy, the other discoid, and found that both germs agreed in being weak fermenters of lactose, weak curdlers of milk, and weak producers of indol. The question presents itself whether the vital arrangements of the mussel could have altered a previously normal strain of Coli in this direction, or whether the sewage matter ingested by the mussel originally contained a typhiform variety of Coli. Every one of these nine mussels was found to contain B. enteritidis. Plate II., fig 5, shows the typically changed milk tubes. whilst the Coli results are reproduced on the same Plate, figs. 2, 3, and 4.

On July 8th I received from Dr. Edgar Flinn six cockles collected by him at "The North Bull," and also six mussels from a spot about 30 yards to the north of that place. Every one of the cockles, and all the mussels save one, yielded typical Coli. (See Plate II., figs. 8 and 9.) Both cockles and mussels proved, without a single exception, to contain enteritidis. (See Plate II., figs 6 and 7.) It should be mentioned that the plate made from the solitary mussel that did not yield Coli was so thickly covered with rapidly liquefying colonies that Coli might very readily have escaped observation. Shell-fish from this locality would, therefore, seem to present a maximal degree of sewage contamination.

This completes the work hitherto accomplished on the oyster layings and cockle strands round the shores of Dublin Bay. The result of the bacterioscopic test confirms in a very conclusive manner the opinion I formed, based upon ordinary inspection of the localities, viz., that they are exposed in a remarkable degree to pollution with sewage, and that the shell-fish occurring naturally, or purposely laid down along these shores, are permanently and of necessity contaminated to a grave extent with the organisms characteristic of sewage, and are therefore liable to serve as vehicles for the conveyance of these germs, and with them of the germ of enteric fever, into the system of persons who use these shell-fish as articles of food.

LAYINGS AT BALDOYLE AND MALAHIDE, COUNTY DUBLIN.

These localities, being on the north of the isthmus which connects the Promontory of Howth with the mainland, are shut off from Dublin Bay. It is, therefore, necessary to deal with them in a separate division of the report. Being situated in the immediate vicinity of Dublin Bay, they may properly be dealt with immediately after it.

Before detailing the result of the examinations, I wish to state expressly that I do not consider that the number of the specimens tested, or the period at which they were collected (before the arrival of the temporary summer population), can be held to justify any favourable generalisation from the almost entirely negative character of the results.

On the 4th May, after visiting and collecting specimens at Sutton, Dr. Browne and I proceeded to Baldoyle, where we collected, not without difficulty, six cockles, together with samples of mud and water. Both the latter looked clean. Tested for Coli, all the cockles yielded negative results, with one exception (No. 3), the stock sub-culture of which was unfortunately mislaid through obliteration of the label, and could not be identified. The only record I have is in the laboratory note-book, and reads as follows:—

"Baldoyle cockle 3, plate too crowded; a second plate made showed filmy coli-form colonies consisting of Bacilli, not unlike typhoid, and actively motile: diplococcal forms intermixed." According to my experience, this would probably have proved to be true Coli. All six cockles evoked the typical enteritidis change in milk. Both mud and water were negative for Coli. Tested for enteritidis, the mud was positive, whilst the water again yielded a negative result.

The material obtained from Malahide consisted of eight oysters from Mr. Petrie's bed, taken at low water by Dr. Browne on May 4th. Six of them were tested as usual. Not one of the six yielded a coli-form colony. Two of them gave development in the phenol-broth, but plating out yielded only cocci. Together with the oysters, Dr. Browne brought in two samples of water, one taken on the layings at dead low tide, the other two hours after the beginning of the flood. Both yielded negative results to the tests for Coli and enteritidis. A sample of the sandy mud from the layings was negative for Coli. It contained the same coccus as two of the oysters. For enteritidis it gave a positive result.

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* On September 11th Dr. Browne and I revisited this locality and collected six oysters, three of which I found to contain *B. coli* in 1 c.c. The water and ground formation taken at the same time gave negative results. [*Inserted during correction of proof.—E. J. McW.*]

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Coast of County of Dublin—*continued.*

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
I. Clontarf American Blue-Point. (22-1-03).				
Oyster No. 1	+	Germ-content 10,000 per c.c.; cocci on plates.		Not tested.
„ No. 2	+	Approximately same germ-content.		„
II. Clontarf "East River" Oysters (laid down 2 months).				
Oyster No. 1	?+	Coli-form on plate; not further tested; germ-content 2,000 per c.c.		Not tested.
No. 2	+	*Aerogenes* type of *Coli* on plate; germ-content 1,000 per c.c., mostly liquefying.		
„ No. 3	+	Filmy *Coli*; also *aerogenes*-like colonies which ultimately liquefied gelatine.		
„ No. 4	+	*Coli* of either variety obtained from each.		
„ No. 5	+			
„ No. 6	+			
III. Clontarf "East-River" Oysters (laid down 10 months).				
Oyster No. 1	+	Done by plate-method only; *Coli* obtained. Germ-content of No. 1, 1,000, of No. 2, 1,500 per c.c.		Not tested.
„ No. 2	+			
„ No. 3	+	*Coli* of either variety obtained from each.		
„ No. 4	+			
„ No. 5	+			
„ No. 6	+			
IV. Clontarf Oysters picked out of heap of dead shells.				
Oyster No. 1	+	Germ-content about 3,000 per c.c. *Coli* on plates.		Not tested.
„ No. 2	+			
„ No. 3	+	*Coli* obtained from all.		
„ No. 4	+			
„ No. 5	+			
V. Oysters from most inland part of layings, Clontarf.				
Oyster No. 1	+	Germ-content, 2000 per c.c.		Not tested.
„ No. 2	+			
„ No. 3	+			„
„ No. 4	+			„
VI. Oysters from a point still nearer the shore.				
Oyster No. 1	+	Very large, old oyster; germ-content 1,000. *B. figurans* and coliform on plate.		Not tested.
„ No. 2	+			„
„ No. 3	+			„

† signifies that the organism tested for was found.
– signifies that the organism was not found.

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Coast of County of Dublin—*continued.*

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
VII. Cockles from surface of Foreshore, Clontarf.				
Cockle No. 1	+	Germ-content 1,000 per c.c. several coliform on plate.		Not tested.
„ No. 2	–			
„ No. 3	+			
„ No. 4	–			
„ No. 5	–			
VIII. "North-Sea" Oysters from Clontarf. (10–4–03.)				
Oyster No. 1	+	*Coli*-content between 100 and 1,000 per c.c.	+	*Enteritidis* in 1 c.c.
„ No. 2	+	Mostly *aerogenes*	–	Change not typical.
„ No. 3	+	Filmy *Coli*	–	Milk unchanged.
IX. "Cork" Oysters from Clontarf.				
Oyster No. 1	+	*Coli*-content between 10 and 100 per c.c.	+	*Enteritidis* in 1 c.c.
„ No. 2	+		+	Change typical, but culture a mixed one.
„ No. 3	+		–	Litmus reduced in lower half of tube.
X. "Carlingford" Oysters from Clontarf.				
Oyster No. 1	+	Germ-content between 100 and 1,000 per c.c.	+	Typical change in all.
„ No. 2	+		+	
„ No. 3	+		+	
XI. Clontarf Sea-water No. 1	–	*Coli* not detected in 1 c.c.	–	*Enteritidis* not found in 1 c.c.
„ „ No. 2	+	*Coli*-content between 10 and 100 per c.c.	–	
„ Mud	–	*Coli* probably overwhelmed by putrefactive organisms.	+	Less than 100 spores of *Enteritidis* per grain.
XII. "American Blue Points" from Sutton, Co. Dublin.* (4–5–03.)				
Oyster No. 1	–		–	
„ No. 2	–		–	
„ No. 3	–	Pseudo *Coli* found	–	
„ No. 4	–		+	
„ No. 5	–		+	
„ No. 6	–		+	
"Portuguese" Oyster from same place.	–		+	
Water from same place	–	Not in 1 c.c.	+	In 1 c.c. water.
Mud „ „ „	–	Not in a knife-pointful	+	In a knife-pointful.
XIII. Merrion Cockles, Group 1. (9–5–03.)				
Cockle No. 1	+	Average amount for each tube, 0·25 c.c. cockle water, and one-half of the mollusc.	+	Same average amount used as for *Coli*. Result typical in all.
„ No. 2	+		+	
„ No. 3	+		+	
„ No. 4	–		+	
„ No. 5	–		+	
„ No. 6	–		+	

+ that the organism tested for was found.
– signifies that the organism was not found.
* *See* foot-note on page 215.

Coast of County of Dublin—*continued.*

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Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
XIV. Merrion Cockles, Group 2.				
Cockle No. 1 - - - -	–	Plate liquefied - - - -	+	Same average amount used as fo group 1.
,, No. 2 - - - -	+		+	
,, No. 3 - - - -	+	Average amount used same as group 1.	+	
,, No. 4 - - - -	+		+	
,, No. 5 - - - -	+		+	
,, No. 6 - - - -	+	No juice, body only used - -	+	
XV. Merrion Cockles, Group 3.				
Cockle No. 1 - - - -	–	One half body used. No juice -	–	Coagulated, but no gas.
,, No. 2 - - - -	+	One half body and 0·5 c.c. juice used.	+	Same amount used as for *Coli.*
,, No. 3 - - - -	–	Average amount used same as for group 1.	+	Amount same as for *Coli.*
,, No. 4 - - - -	+		+	
,, No. 5 - - - -	+		+	
,, No. 6 - - - -	+		+	
Water from Merrion - - -	–	*Coli* not found in 50 c.c. - -	–	Not in one c.c.
Mud ,, ,, - - -	–	Whole sample tested - -	+	In a knife-pointful.
XVI. Cockles from opposite Victoria Terrace, Clontarf. (19–5–03.)				
Cockle No. 1 - - - -	+		+	
,, No. 2 - - - -	+		+	
,, No. 3 - - - -	+		+	
,, No. 4 - - - -	+		–	Change not typical.
,, No. 5 - - - -	+		+	
,, No. 6 - - - -	+		+	
XVII. Cockles from opposite "Watson's House," Clontarf.				
Cockle No. 1 - - - -	+		+	All yielded the typical change.
,, No. 2 - - - -	–	These to failures to isolate *Coli* appears due to overgrowth by putrefactive germs	+	
,, No. 3 - - - -	–		+	
,, No. 4 - - - -	+		+	
,, No. 5 - - - -	+		+	
,, No. 6 - - - -	+		+	
XVIII. Cockles from the strand at Irishtown, Co. Dublin. (25–5–03.)				
Cockle No. 1 - - - -	+		+	Typical change in all.
,, No. 2 - - - -	+		+	
,, No. 3 - - - -	–		+	
,, No. 4 - - - -	–		+	
,, No. 5 - - - -	–		+	
,, No. 6 - - - -	–	Ciliated branchial epithelium rendered phenol-broth turbid.	+	

+ signifies that the organism tested for was found.

- signifies that the organism was not found.

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Coast of County of Dublin—*continued.*

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
XIX. Mussels from Blackrock, Co. Dublin. (11–6–03.)				
Mussel No. 1 - - - -	+		+	Typical change in all.
,, No. 2 - - - -	+		+	
,, No. 3 - - - -	+		+	
,, No. 4 - - - -	+		+	
,, No. 5 - - - -	+		+	
,, No. 6 - - - -	+		+	
,, No. 7 - - - -	+		+	
,, No. 8 - - - -	?–	Pseudo *Coli* - - - -	+	
,, No. 9 - - - -	+		+	
XX. Cockles from North Bull, Dublin. (8–7–03.)				
Cockle No. 1 - - - -	–		+	
,, No. 2 - - - -	+		+	
,, No. 3 - - - -	+		+	
,, No. 4 - - - -	+		+	
,, No. 5 - - - -	+		+	
,, No. 6 - - - -	+		+	
Mussels from near same place.				
Mussel No. 1 - - - -	+		+	
,, No. 2 - - - -	+		+	
,, No. 3 - - - -	?–	Liquefiers may have obscured *Coli.*	+	
,, No. 4 - - - -	+		+	
,, No. 5 - - - -	+		+	
,, No. 6 - - - -	+		+	
XXI. Baldoyle Cockles. (4–5–03.)				
Cockle No. 1 - - - -	–		+	
,, No. 2 - - - -	–		+	
,, No. 3 - - - -	?+	Probably *Coli* - - - -	+	
,, No. 4 - - - -	–		+	
,, No. 5 - - - -	–		+	
,, No. 6 - - - -	–		+	
Water from same place - -	–	Not in 1 c.c. - - - -	–	Not in 1 c.c.
Mud ,, ,, - - -	–	Not in a knife-pointful - -	+	In a knife-pointful.
XXII. Malahide Oysters. (4–5–03.)				
Oyster No. 1 - - - -	–		–	Grain-staining Bacilli, but milk alkaline separated into layers.
,, No. 2 - - - -	–		+	
,, No. 3 - - - -	–	Cocci - - - - - -	+	
,, No. 4 - - - -	–	Cocci - - - - - -	–	Litmus-milk bleached, not coagulated.
,, No. 5 - - - -	–		+	
,, No. 6 - - - -	–		–	Solid clot, no gas.
Water from same place at low tide	–	Not in 1 c.c. - - - -	–	Not in 1 c.c.
Water from same place 2 hours after commencement of flood	–	Not in 1 c.c. : - - -	–	
Mud from same place - - -	–	Cocci, no *Coli* in a knife-pointful	+	In a knife-pointful.

+ signifies that the organism tested for was found.
– signifies that the organism was not found.

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Coasts of Counties of Wicklow and Wexford.

The shellfish from this locality consisted mainly of deep-sea oysters, obtained by dredging. They were amongst the largest I have seen, the diameter of the flat shell averaging five inches. They were curiously encrusted with marine organisms. Taken as they were from the bottom of the sea, several fathoms deep and some miles off a sparsely inhabited coastline, these oysters could not be suspected of sewage contamination. For this reason the result of their examination furnishes valuable evidence of the reliability of the bacterioscopic test. Here, indeed, it may fairly be said that it is the test itself which is being tested, not the shellfish. How fully the test justifies the expectations that have been based upon it may be seen by glancing down the result columns of the tabulated statements appended. In the Coli column only negative results are shown, with the solitary exception of a locality, the conditions prevailing at which I do not know, but which was described by Dr. Browne on the label of the packet as "close to the Dockyard, Wexford."

It will be further noticed that not only is Coli absent from all the deep-sea beds, but that enteritidis is also either absent altogether, or, if present, represented in number so small as to be unable to produce the typical change in milk, either at all, or in the usual time. This can hardly be a mere coincidence, and the circumstance would appear to show that the concomitant absence of this organism may have at any rate a negative value in examinations of this kind.

Source and Nature of Material.	Tested for *B. coli communis* by Phenol-broth method.		Tested for *B. enteritidis sporogenes* by Klein's method.	
	Result.	Remarks.	Result.	Remarks.
I. Oysters dredged off North Pier, Arklow (24–4–03.)		Very large plump oysters.		
Oyster No. 1 - - - -	–	Phenol-broth remained sterile	–	All unchanged in 24 hours. In 48 hours No. 1 was slightly bleached (litmus-milk was used). In 96 hours No. 1 was bleached below, No. 2 showed atypical change (clot solid, no gas). No. 3 was slightly bleached below.
„ 2 - - - -	–		–	
„ 3 - - - -	–		–	
II. Oysters from Mizen Head, Brittas Bay (Co. Wicklow), dredged (25–4–03.)		Large oysters, not so plump as No. 1 batch.		
Oyster No. 1 - - - -	–	All remained sterile - -	–	Became bleached throughout, alkaline on surface.
„ 2 - - - -	–		–	No change.
„ 3 - - - -	–		–	
III. Oysters and mussels dredged off Norris Castle C.G.S. (Co. Wicklow).		Large plump deep-sea oysters.		
Oyster No. 1 - - - -	–	All remained sterile -	–	Lower half became bleached.
„ 2 - - - -	–		–	Litmus turned red above, semi-translucent serum below, disgusting smell.
„ 3 - - - -	–		–	Unchanged in 4 days.
Mussel No. 1 - - - -	–	Yellow liquefying coccus obtained.	+	Atypical change, clot a little too solid. Micro., typical *enteritidis* mixed with sporing bacilli.
„ 2 - - - -	–	Remained sterile - - -	–	Remained sterile.
„ 3 - - - -	–		–	
IV. Oysters from Public Oyster Bed off Dogger Bank at entrance to Wexford Harbour.		Enormous oysters.		
Oyster No. 1 - - - -	–	All negative - - - -	–	
„ 2 - - - -	–		–	
„ 3 - - - -	–		+	Change doubtfully typical, but typical bacilli found microscopically.

+ signifies that the organism tested for was found.

— signifies that the organism was not found.

Coasts of Counties of Wicklow and Wexford—*continued.*

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V. Mussels from Slaney River close to Dockyard, Wexford, taken 19-4-03.				
Mussel No. 1	–		–	Change looked almost typical, and Gram-staining rods found, but they contained *spores*.
„ 2	+	Large irregularly fringed *Coli-form* colonies, consisting of small lazily motile bacilli, proved to be genuine *Coli*.	–	Remained unchanged.
„ 3	+		+	Typical change in 24 hours.
VI. Cockles from Strand outside Breakwater, Wexford, taken 27-4-03.		Fine large cockles.		
Cockle No. 1	–	All three yielded streptococci, forming beautiful small pearly-white colonies, not liquefying the gelatine, and producing uniform turbidity in broth.	–	Change atypical.
„ 2	–		+	Change came on slowly.
„ 3	–		–	Litmus milk-displayed parti-coloured layers.

E. J. McWeeney.

August, 1903.

19484*. (*Sir Michael Foster.*) I see that you have your own views as to the trustworthy diagnostic characters of the genuine Bacillus coli?—(*Professor McWeeney.*) Well, I do not know that my views are quite special to myself. The impression I am under is that they are shared by the greater number of men who have worked to any degree in that direction.

19485. I see that in several respects you agree with Klein?—I do.

19486. But in some respects you differ?—Well, of course, as the result of one's experience one may sometimes have to differ from another man—another worker.

19487. He, for instance, regards the gas bubbles in the shake gelatine as a characteristic test?—Yes.

19488. You, I see, put that in quite a secondary position?—Precisely so; I find that working with ordinary nutrient gelatine, without the addition of carbohydrate material, bubbling as often as not fails to take place. I mean that in about 50 per cent. of cases you would get bubbling and in the other 50 per cent. you would not. If, on the other hand, you add a little carbohydrate deliberately, you would have bubbling in every case.

18489. The difference is due probably to the method of preparing the gelatine. Klein in preparing the gelatine probably always insures a certain amount of muscle sugar, which supplies the necessary amount of carbohydrate?—I think that is probable.

14890. So that really the difference is not very great between you?—I do not consider it an important difference.

14891. His gelatine may always be taken to contain a certain amount of carbohydrate, which gives the bubbles?—Yes.

14892. And you would say that without carbohydrate the gelatine does not give the bubbles?—Precisely so. My experience goes a little further. I have had a little experience with media, which I have completely freed from carbohydrate by Smith's method, and I have found on gelatinising the medium, turning it into nutrient gelatine, that I comparatively rarely get gas bubbling.

19493. Then I see that he insists rather upon glucose as well as lactose for the fermentation test; you trust to lactose alone?—I trust to lactose alone, because my experience is that genuine coli always ferments lactose with the evolution of gas and acids, whereas a considerable number of pseudo-coli species which I have come across ferment glucose, whereas they do not ferment lactose.

19494. He takes the glucose and lactose together; you take the lactose only; you are satisfied with the lactose?—I am satisfied with the results of lactose.

19495. I see you favour the Parietti method; that is the phenol method?—Yes, the phenol method is what I conceive to be good.

19496. That is objected to, or at all events not given the first place as a medium by some bacteriologists under the idea that the phenol has an inhibitive action?—Of course, a good deal will depend upon the dosage of phenol, but the experience which I have had leads me to the belief that if you add a proper percentage of phenol you will just hit off the happy medium. You will not inhibit the growth of coli or similar organisms to any very great extent, whereas you will prevent your tubes from being contaminated with liquefying non-coli-form organisms—putrefactive ones.

19497. Then do you think that your preparation of penol-media differs from that of other observers who are not so favourable to the method?—Quite possibly.

19498. Then I observe that you trust simply to the mere presence, or absence, for instance, of bacillus coli. You say present or absent in so many oysters, for instance, out of the lot?—Well, I do not know that I quite take up that position. I have always measured the amount of the material from the oyster which I have tested from bacillus coli, and if you refer to my opening statement, sir, you will see that I mention that the amount is one cubic centimetre. You see, when one has to deal with a very large amount of material—I mean with a very large number of oysters at once, at any rate with the laboratory resources which I have, it would have been quite impossible to think of ascertaining numerically the coli contained per c.c. I was obliged to adopt one course and adhere to it, and I decided to make my standard the presence or absence of coli in one c.c. of oyster fluid.

19499. Do you not think there is something to be said in favour of determining the quantity?—Oh, most decidedly.

19500. I mean it is much more trustworthy, is it not?—Well, it is much more trustworthy in so far as it adds additional information; it gives us information which we did not have before, but on the other hand I do not think that it can be regarded as any more trustworthy *quâ* statement than to state whether or not bacillus coli is present in one c.c.

19501. Would not one be inclined, as an evidence of sewage contamination, to place greater trust in the statement that there were so many—for instance, a very large number of coli in the oyster as against a case in which you had only evidence of it presence, and one coli might have supplied this?—That I think might depend very largely upon the subsidiary statement as to whether good oysters that are entirely uncontaminated do contain even one coli per c.c.

19502. But is it not of very considerable value, as an evidence of contamination, to know whether, say, your one c.c. contains—I am only just taking rough numbers—one coli, or it contains 10,000?—Quite so. I do not want to be taken as denying that position at all. I think that is a very proper position, and it is a position upon which I should have very much wished to have been able to give the Commission information, but, as I have explained, it was not possible for me to accom-

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plish so much. When I had, say, 70 or 80 oysters from different sources sent in at once, it was a matter of absolute impossibility, with my laboratory resources, to do more than to ascertain whether or not coli was present in unit of volume of contents.

19503. But you would agree that, for instance, in an examination previous to taking any legislative measure, a quantitative examination would be most desirable?—I think so, and, as a matter of fact, I did attempt, as you will see on referring to my paper, a quantitative estimate in the case of certain oysters which *à priori* seemed likely to contain a considerable number of coli per c.c., namely, those from Clontarf, in the neighbourhood of Dublin, and if you will refer to that you will see that I do give the quantity per c.c.

19504. Then in common with other observers you find, I see, a very remarkable want of correlation between the bacillus coli and the sporogenes enteritidis?—I do.

19505. And I think in one or two cases in the absence of evidence of coli you had very clear evidence of enteritidis?—Oh, I frequently found enteritidis on occasions when the coli was absent.

19506. Did you as often find the coli when the enteritidis were absent?—No.

19507. My impression is after looking very rapidly over your results that that was the case?—Quite so. I have not made out statistics based on this yet, because I do not regard the work as concluded, but I think you are quite right in saying that when I found coli I also found enteritidis. On many occasions, however, I found enteritidis when no coli was to be detected.

19508. (*Mr. Power.*) You are speaking of mud there, are you not?—I am speaking generally of shellfish, mud, and water. But with reference to the mud, since you have mentioned it I should like to say I have examined very few specimens of mud in which enteritidis did not prove to be present.

19509. Although coli was there?—Although coli was absent.

19510. Coli was absent and enteritidis was absent also?—Enteritidis was present. I say I have examined very few samples of mud in which I failed to find enteritidis. In other words, my general view would be that enteritidis is almost a normal denizen of mud, that is mud which is heavily charged with organic matter.

19511. (*Sir Michael Foster.*) Are your observations sufficiently numerous to enable you to say?—I have examined a great many specimens of mud.

19512. How many?—Well, I cannot say the exact number, but I have examined a great number. You could see the exact number on reference to the paper. I suppose I might have examined 50 or 60 or 70 specimens of mud, and my general impression is that I found enteritidis is about 80 per cent. of these.

19513. Were not the majority of these cases of mud taken from places where there was a possibility of sewage contamination?—A great many samples were taken from places that proved to be absolutely pure from sewage contamination.

19514. How absolutely proved?—Well, what I mean is absolutely proved in this sense, that Dr. Browne's findings and my finding agreed.

19515. You mean that there was no topographical evidence?—There was neither topographical evidence nor bacteriological evidence. Now, for instance, here in the west of Ireland.

19516. You took the mud from situations where the topographical evidence was distinctly against any sewage contamination?—Well, I did not take the mud; Dr. Browne took the mud.

19517. I am speaking now of Dr. Browne's evidence?—He took the mud, and in many cases I found enteritidis in it, although the evidence was altogether against sewage contamination.

19518. I do not feel quite sure what is your meaning on page 92 of your report. I rather gather from that that you think the enteritis has a widespread origin quite independent of the intestinal canal?—Yes, that is my view.

19519. Is there not this little point to be borne in mind, that it is very resistant—the sporogenes?—Oh, yes.

19520. And therefore might be carried, I mean, longer distances and be more widespread, and in one way might be the very last indication of sewage contamination?—That position is not to be denied; on the other hand, there would go with it the further fact that the resistant pathogenic organisms derived from sewage contamination would by then have disappeared, and hence the diminished hygienic value of the determination.

19521. That is a different question?—Yes.

19522. One was looking at the problem of the origin of these sporogenes enteritidis. We know, I mean, that it is discharged from the bowel, do we not?—We do.

19523. Together with the coli, and being more resistant than the coli, it might survive—Yes.

19524. In cases where the coli had disappeared?—It would survive, most undoubtedly.

19525. So that is it not quite possible that it should be of intestinal origin exclusively, widespread as it is?—Well, I do not deny the possibility of it, but then, on the other hand, we cannot regard it as having originated *de novo* in the bowel. If it is in the bowel it must have got into the bowel somehow from outside.

19526. That applies to coli as well, does it not?—Precisely so.

19527. But you have no definite external evidence, have you, of the extra intestinal origin of enteritidis; have you made any observations on that point?—I cannot say that I have; but on the other hand I have read certain observations by others which seem to me to rather indicate that it might have an extra intestinal origin.

19528. To a greater extent than coli. I mean it is a question, is it not, of using them both as an indication?—Yes.

19529. Of a certain value only?—Yes.

19529*. As to material having come from the bowel at some distance off?—Yes.

19530. Are they not both of value for that purpose?—Yes. I would not refuse to enteritidis all value, but I certainly do not think that it has anything like the same value as bacillus coli from the hygienic standpoint.

19531. But I mean as evidence of sewage contamination, taking into consideration its greater resistance, which would account, although having come from the bowel, of its still being found, although the coli had disappeared?—You see, we want some evidence that it really has come from the bowel. That is the point, that is the missing link which requires to be bridged over in my mind before I can give an unconditional acceptance to the point of view that you suggest.

19532. I mean, it is only the relative value of the two, bacillus coli and the sporogenes. You lay great stress on the coli, and you throw the sporogenes almost entirely over?—I do not know that I should quite select these words to state it.

19533. That is the impression which I have got from reading your report.

19534. (*Mr. Power.*) Do you suspect that enteritidis grows and multiplies outside the animal body, whereas bacillus coli does not?—Well, it is rather a difficult question to answer. I do not consider that I know enough about the life history of enteritidis sporogenes to give an answer to that one way or another. You see under laboratory conditions enteritidis grows very slowly at room temperatures; it grows quickly at the temperatures of the incubator, and precisely whether the conditions for its rapid multiplications are found in outside nature, I do not know; I should be slow to answer that question.

19535. But still you think there are other sources of enteritidis than the intestine; are you not thinking of it from that point of view? I gathered that from what you answered to Sir Michael?—Well, there are other things.

19536. (*Sir Michael Foster.*) By intestine we do not exclusively mean a human intestine?—Yes, well, there are other things. There are other organisms which appear to—well, perhaps I had better not commit myself further in the matter than to say that I prefer not to give a definite answer to that question; I have not thought it over from that point of view.

19537. (*Mr. Power.*) As to your laboratory results, Professor McWeeney, have they in the main agreed with indications obtained from topographical and physical investigations of the locality?—Well, they have really to a very remarkable extent, I think; they have agreed.

19538. Have they agreed to this further extent that where the indications from survey have been strong the bacteriological results have been also strong in the direction of contamination?—Yes, with certain exceptions that statement is true.

19539. Supposing the locality was passed as uncontaminated by the inspector surveying it, would you hesitate to condemn it by laboratory results, showing an abundant bacillus coli, or the mere presence, we will say, of bacillus coli?—Well, if I found an abundance of bacillus coli in many of the oysters, or in the water, or in the mud, and if nevertheless the inspector found that there was no evidence of local contamination, I should certainly suggest that a second and closer examination be made. I think, if I might mention it, I had a rather striking example of the importance of that quite recently in the case of an oyster bed in Kenmare, at a place called Kenmare River, in the south-west of Ireland.

19540. (*Sir Michael Foster.*) Is that in your report; is it referred to in your report?—Yes, the oyster bed is mentioned here.

19541. Kenmare; yes, I have it?—The Kenmare River, No. 3; it refers to oyster bed No. 3.

19542. From the Dereen beds?—The Dereen beds. You see my results there. I got undoubted coli in three of the oysters, and pseudo-coli in a fourth, and the results of the local investigation were purely negative. However, we were not quite satisfied with that; I thought that was rather a test case, a case in which we ought to go over the local examination again. Accordingly, I accompanied Dr. Browne to the scene, and we found that there was a very small stream, not, perhaps, wider than that inkstand, running into the sea at a distance of about 300 yards from the beds, and this stream carried with it the overflow from a cesspool belonging to the manor house. That little stream itself seemed quite unpolluted; at least it was inodorous and clear. I collected a sample, took it back with me to Dublin, examined it, and found it contained between 10,000 and 100,000 coli per c.c. This was being delivered into the head of the bay, within about 300 yards of the oyster beds.

19543. (*Mr. Power.*) And in that instance the result of bacteriological tests brought about a re-survey of the locality?—It brought about a re-survey of the locality; it directed attention to a feature which had hitherto escaped attention.

19544. Would the converse of that—the other kind of discrepancy—occur? While the survey revealed contamination, the laboratory results passed the sample?—Yes, it did; that is a very curious thing; that happened in the case of beds at Carlingford Lough.

19545-6. (*Sir Michael Foster.*) This is the case where you had the enteritidis, and not the coli?—This was the case where we had the enteritidis, and not the coli. I confess it did not suggest itself to me from that point of view; however, there was an absence of coli, at any rate.

19547. I was very much struck with this. This is the case that particularly struck me on looking over your report?—Yes.

19548. The coli is absent throughout?—It seems very strange, I must say. If you will allow me for one moment, this is a case which I have again examined.

19549. (*Mr. Power.*) I was going to ask, did you take a further sample in that case?—I have repeated the examination, and the results are not yet complete. I was actually looking at it the week before last, and I have not fully tested the different organisms. I have not run them through the gamut of the various tests, but this much I can say, that coli-form organisms have appeared on the cultivations from a great many of the oysters, at least half of the oysters from these first three or four beds, with regard to which we obtained negative results on the first occasion.

19550. From oysters and beds?—From oysters and beds I have got coli-form organisms, and so far as my testing has gone they are proving to be the genuine thing. As matter of fact the only test I have not subjected the great number of these recently isolated organisms to is the indol test. That I have not done because I do not think sufficient time has elapsed before testing them for indol; I leave them a month in the broth before testing for indol.

19551. Generally speaking, I suppose you would attach greater value to the positive result bacteriologically than to the negative, would you?—I would, yes, most decidedly.

19552. (*Sir Michael Foster.*) There are no particular conditions in this Carlingford Lough to which one might appeal as being probably prejudicial to coli?—Well, a very curious thing has arisen about these particular layings. There appears to be some suspicion—Dr. Browne suggested to my mind some suspicion that these particular oysters in which I failed to find coli had not been down on the layings for more than a few hours; I rather gathered that an attempt had been made to select oysters that had not been laid very long.

19553. These are American-laid oysters?—(*Dr. Browne.*) They had only been on the bed for a day. (*Professor McWeeney.*) They would appear to have selected oysters that had not been there very long, the most recently put down oysters, and that might possibly account for the negative results I have had.

19554. Have you examined any American oysters directly imported?—No, unfortunately, I have not had the opportunity of examining imported oysters before they had been laid down.

19555. (*Sir Michael Foster.*) We might ask Dr. Browne (*showing a map of the layings in question*). The quantity of water which comes down from Newry is very small?—(*Dr. Browne.*) Very small—the fresh water, you mean?

19556. The fresh water?—The quantity is not large at any time.

19557. And the quantity of pure sea water which is coming in is, relatively to the fresh water, very large indeed?—I should say so, very large.

19558. (*Mr. Power.*) Have you made any observations as to the length of time coli can survive in shellfish?—(*Professor McWeeney.*) I have made no systematic observations, sir, but I had occasion to accidentally make an observation which throws some light upon the matter. It refers to a parcel of oysters which was sent to me for examination, but which my laboratory porter forgot to bring up to the laboratory. They stood for 11 or 12 days in the refrigerator. I went down to the refrigerator and found this parcel in it, saw the date on it, and opened it, expecting to find the oysters dead, and perhaps in a state of decomposition, but I found every one of them alive, and tightly closed. I proceeded to examine them, and found coli in a very large percentage; I think in 50 or 60 per cent. of them—more than half the batch.

19559. (*Sir Michael Foster.*) Where did they come from?—This particular batch of oysters came from Carlingford; 24th September, I remember, was the date on them; yes, they came from Carlingford.

19560. From the layings of which we are now speaking?—Dr. Browne now tells me they came from Ballisodare, in County Sligo.

19561. (*Mr. Power.*) And you obtained typical coli from these oysters?—I found typical coli in them. I was so much interested in them that I ran them through the tests, and after a week I tested the original broth cultures for indol, and that was the final test; there was no doubt that they were genuine coli.

19562. (*Sir Michael Foster.*) And how long had they been?—They had been for 12 days from the period of collection, but, of course, it must be remembered that they were kept at a low temperature for 11 or 12 days.

19563. And with closed shells?—And with closed shells. And again I think, if I might call attention to one other point, that I make no attempt to distinguish coli in the shell water, and coli from the interior of the oyster—the fluid which I subjected to examination was a mixture of shell water and body fluid. May I make another remark with regard to these discrepancies, roughly, arising between laboratory results and the results of local inspection? Dr. Browne has just reminded me of it. Dr. Browne and I took samples from a place called Sutton, in Dublin Bay, early in the season, before the summer population comes to live along the sea-shore, and these samples gave negative results. Subsequently we took other samples towards the end of August—I think it was towards the end of August, or

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early in September, when the summer population had come there, and we got coli from a great number of the specimens examined.

19564. (*Mr. Power.*) As to the presence or absence of coli in sea water at the different depths, have you made any observations in that direction?—I have made some observations, but unfortunately they have not been of a systematic kind. I have not been able to take up the subject systematically, but I have had occasion to examine three samples of sea water collected by a friend of Dr. Browne's, who has a yacht, some distance out from the south coast of Ireland, I think it was, two or three miles from the shore—more—and I failed to get coli in 100 c.c. of the water.

19565. You failed to find it in 100 c.c. of the water?—I failed to find it in 100 c.c. of the water.

19566. That was surface water, I suppose?—I could not say as to that. (*Dr. Browne.*) The locality from which the samples were takes was not very far from Daunt's Rock, off the entrance to Cork Harbour.

19567. There would be a considerable depth of water, I suppose?—Yes. I should think there would be.

(*Professor McWeeney.*) It is out in the open sea.

(*Dr. Browne.*) About three miles off the coast.

19568. That was one observation, or was it repeated? Three. (*Professor McWeeney.*) Three observations.

19569. (*Sir Michael Foster.*) Did you examine that for sporogenes, too?—I examined only one c.c.

19570. (*Mr. Power.*) You examined the whole 100 c.c.?—No, unfortunately I did not. It would have been highly interesting if I had; I only examined one c.c. for sporogenes.

19571. (*Sir Michael Foster.*) And you——?—Found negative results.

19572. (*Sir William Ramsay.*) I notice you distinguish between different kinds of coli?—Yes.

19573. Have you tried with intestinal fluids of human beings to see whether there are spurious coli?—Unfortunately not systematically; my knowledge of that depends largely upon my experience in hunting for typhoid in human intestinal discharges; presumably in cases of typhoid fever one ought to be able to get the typhoid bacillus easily enough from human discharges, but every bacteriologist knows it is a very difficult thing to do, and in the course of my work I have had to study a considerable number of coli-form strains and coli-form races, which I had cultivated from typhoid discharges, but which proved not to be good typhoid, and my experience is that most of those—the great majority of them—proved to be genuine coli, as judged by those tests which I have given.

19574. No, but would you take it then, that the existence of such spurious coli, say, in an oyster fluid would point towards sewage contamination at all; would point towards the oyster having been in contact with intestinal fluid or not. Let me put the question to you in another way; have you come across any other material that contains quantities of spurious coli?—No, I have not; my general impression is that spurious coli has something of the same significance. One has to be very cautious; I wish to be particularly cautious here, but I do not know of any material which to my knowledge could be relied upon as containing pseudo-coli, except excremental matter.

19575. Another question. Have you made any experiments with such spurious coli to see if they are toxic?—Oh, I have; I have often injected pseudo-coli *intra-peritoneally*, for various purposes, and found that it did not differ very markedly in virulence from genuine coli. If you injected a large dose *intra-peritoneally*, it very usually produced *septicoemia*. Sometimes toxæmia was produced.

19576. But upon the whole, I suppose you would take it these pseudo-coli are as strong an evidence of sewage contamination as genuine coli?—I would not like to say as strong, pending a systematic examination of excremental matter, with a view to ascertain what was the percentage of pseudo-coli in relation to that of true coli. It is rather premature to make any such statement as that.

19577. (*Sir Michael Foster.*) Have you made any observations yourself about forms of coli or sporogenes in the intestines of sea birds, and so on?—Unfortunately I have not.

19578. You refer to the possibility of that?—Yes. I refer to the possibility. I should like very much to be able to give the Commission some information on that. It is a subject, I think, which would deserve to be taken up, but you see one has so much to do.

Mr. E. W. L. Holt.

Mr. E. W. L. Holt, of the Department of Agriculture, Ireland, called; and Examined.

19579. (*Chairman.*) You are Mr. Holt, Scientific Adviser to the Department of Agriculture, Ireland, and you have submitted a memorandum which I propose should be entered on the minutes of evidence?—Yes, my Lord. I may first state that my duties as Scientific Adviser do not embrace administrative matters, but in discussing the matter of pollution of shell fisheries it is extremely difficult to deal separately with the scientific aspect of the matter, and the administrative considerations dependent thereon. I have, therefore, been authorised by the administrative officers of my branch to express my views upon the whole question, but in the event of the Commission asking any question which would lead me beyond matters of which I have cognisance, it will be necessary for me to refer to the administrative officers.

MEMORANDUM OF EVIDENCE FOR ROYAL COMMISSION ON SEWAGE DISPOSAL.

Prevention of Contamination by Sewage Pollution.

Sewage pollution may be classified as follows:—

(i.) Pollution which may follow as the result of new sewage works.

(ii.) Pollution caused by existing sewage works or contamination of any sort.

In the case of (i.) it is now customary for the controlling authority to refer any new sewage scheme to the Fishery Authority, for their observations. The Fishery Authority has thus an opportunity of objecting to the scheme if, in their opinion, the carrying out of the scheme would have a deleterious effect on oyster or other fisheries existing or likely to be developed; and no doubt such objections receive due attention from the controlling authority. It may, however, be taken for granted that the decision of the controlling authority would be based on a consideration of all the interests involved, and in some cases a shell fishery might of necessity suffer.

It would not be reasonable to seek power to absolutely veto any sewage scheme which would imperil a fishery, and I am unable to form an opinion as to the practicability of imposing and enforcing restrictions in the way of purification to an extent sufficient to make them of real use.

In addition to licensed fisheries, which may be determined by the Act of the Department, a number of oyster fisheries are held in Ireland as under charter from the Crown, and over these the Department have only such control as is conferred by Acts dealing with the close season, and general regulation of fisheries whatsoever.

The prevention of pollution by closure of beds which may be found to be polluted appears, under existing legislation, to be outside the powers of the Department, although power exists to close public beds for three years, if for the benefit of the fishery. Moreover, it may be most undesirable in some cases to absolutely close a polluted bed, provided that steps can be taken to prevent shellfish from such bed reaching the consumer before they have been submitted to an effective period of isolation. I shall refer to this subject later.

Without having recourse to fresh legislation it would appear to be competent for the Department to issue to owners of fisheries which may be found unpolluted certificates of non-contamination. A somewhat similar practice obtains in the United States, where at least in one State certificates are issued by the State Inspector of Oyster Fisheries. The following are two specimens of these certificates:—

STATE OF NEW YORK,

Forest, Fish, and Game Commission.
B. Frank Wood, Supt. of Shellfisheries,
No. 1, Maddison Avenue,
New York,
3rd January, 1903.

This will certify that the oysters known in the trade as "East Rivers" are taken from beds situated in Long Island Sound, an important arm of the sea extending for 120 miles between the south coast of the the State of Connecticut and Long Island, in the State of New York, its greatest width being about 20 miles, narrowing to about two miles at its western extremity, averaging about 12 miles wide. These beds are remote from any possible contamination by sewage or otherwise, many of them being at a depth of 60ft. under pure sea water.

Dated New York, January 3rd, 1903.

B. Frank Wood,
State Superintendent of Shellfisheries.

STATE OF NEW YORK,

Forest, Fish, and Game Commission.
B. Frank Wood, Supt. of Shellfisheries,
No. 1, Maddison Avenue,
New York,,
3rd January, 1903.

This will certify that the oysters known in the trade as "Blue Points" are taken from beds located in Great South Bay, a great expanse of salt water lying along the south shore of Long Island, in New York State, and, with its extensions known as Morishes Bay and Shinnecock Bay, having a total length of about 60 miles. These bays are from two to six miles wide, and separated from the Atlantic Ocean by narrow strips of sand beach, through which are many inlets allowing the ocean tides to regularly ebb and flow. The oyster beds are at an average distance of about two miles from shore. The south shore of Long Island is sparsely settled, and there is no possibility of sewage or other contamination.

Dated New York, January 3rd, 1903.

(Signed) B. Frank Wood,
State Superintendent of Shellfisheries.

Such a certificate would appear to me to be too general in terms for adoption in this country, and I would prefer a form which, with due differences according to condition, would be roughly as follows :—

The oyster bed known as A and B in the county of C has been inspected on behalf of the Department on such and such a date, and was then found either—absolutely free from sewage contamination, or free from reasonable risk of contamination.

Here would follow a brief note of the locality of the bed in regard to possible sources of pollution.

Such a certificate would be given under the seal of the Department on the report of the Scientific Adviser, who would be charged to take the necessary steps (including the provision of expert bacteriological assistance) before reporting. The certificate would be available for one season only, and would be withdrawn if in the course of the season a fresh source of pollution should be found to have arisen.

Its issue and withdrawal would be advertised by the Department in such manner as they might think advisable.

The defect of the certificate system, of course, arises in the difficulty ensuring that a certificate be not used to cover oysters from polluted areas ; and to deal with such mis-use efficiently would require legislation.

In the retail trade there might also be considerable difficulty in persuading the customer that the particular dozen of oysters supplied to him were derived from a consignment from a certificated bed. Producers would probably be able to pack and secure their consignment in such a way that the cases could not be used again without the fact being apparent, and as a large part of the Irish native trade appears to be done in comparatively small consignments this is of importance.

The general system of branding at the place of origin seems impracticable, owing, among other reasons, to the varying importance of the productive areas, and to their remoteness one from the other.

Turning to the question of polluted areas which are important in production, it appears most undesirable to close these altogether. At least one area under suspicion of pollution—Carlingford Lough—is the seat of a public fishery of great importance as a means of livelihood to the people of the neighbouring villages. The number of men employed in 1902 was about 263, and the annual value about £2,212, while the oysters are among the best produced in Ireland. Other polluted localities, although of little or no present importance in natural production, have valuable properties for relaying, and the Commission is aware that so far from being harmful to the oyster, a certain amount of sewage is actually beneficial, acting as a fertiliser which increases the production of diatoms and other food organisms ; and, no doubt, in excessively polluted areas, serving directly as food. In China I understand oysters are intentionally fed with crude human ordure, and thrive thereon excessively.

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The dangerous bacilli do not, as the Commission is aware, breed in the oyster as they do in the cockle, and a period of isolation in pure water of about a fortnight is sufficient to free the oyster of them entirely.

It would therefore seem desirable to devise a scheme which would provide for the isolation of oysters from polluted beds before they are placed on the market. To be effective such isolation would have to be supervised if not actually carried out by some authority, such as the Department, and in the case of public fisheries it seems reasonable that the authority should bear some portion of the cost.

Without going into details I may say that I believe that, having regard to the areas which are known to be or may be found polluted, the difficulty of selecting layings suitable for isolation and of administering the isolation, etc., would not be insurmountable.

I do not think the public would have any satisfactory guarantee unless the process were supervised by the State. The period, I think, should be not less than a month. My observations, as far as they go at present, seem to show that an oyster from a rich fattening bed, placed in an uncontaminated bed having no special fattening properties, will not seriously deteriorate during that period.

Isolation, as suggested above, could not be administered without legislation. It is necessary in the first instance that some authority should be empowered to prohibit under severe penalty the taking of oysters for sale, etc., etc., from a polluted bed, and provision would have to be made, with due elasticity, for the control of isolation beds, issue of certificates, etc.

It would probably be convenient that such authority should be the fishery authority, acting either independently or in concurrence with the sanitary authority, but it is important that the spheres of influence of these bodies should not overlap, as serious inconvenience might arise from inadvertence on the part of either.

A further source of pollution is harder to deal with, viz.; pollution which may take place on the premises of the merchant, by dirty store tanks or impurity of fresh water used for "drinking" oysters. I do not see how this is to be prevented except by rigorous inspection on behalf of the sanitary authority, who may not at present possess the necessary powers.

I may mention that in the United States experiments are at present being carried on with a view to finding a commercially practicable method of fattening oysters by the agency of ordinary artificial fertilisers—phosphates and the like—the action of the phosphate is of course indirect as in the case of matter brought down by rivers. By increasing the food supply in this way I understand that it has been found possible to make oysters from a non-fattening bed really fat, as distinct from the swollen watery condition which may be imparted to a lean oyster by "drinking" or "plumping" it in fresh water. The experiments, however, do not as yet appear to have brought the process within practically commercial limits.

In the case of cockles I do not see any way of protecting the public except by empowering an authority to absolutely prohibit the taking of cockles from an infected area.

Isolation is of no use in the case of cockles, even if they were sufficiently valuable to bear the cost. In some places in Ireland they are eaten raw, and, even when cooked, the temperature to which they are subjected is not, I believe, sufficient to sterilise them.

Mussels are not worth the expense of isolation, and the only method of dealing with them would seem to be the prohibition of their sale for human consumption (with due machinery for the enforcement of this prohibition) if taken from infected areas.

Periwinkles which support a considerable industry in Ireland, and whelks do not appear to be liable to harbour bacilli, since their method of feeding is entirely different from that of bivalve molluscs ; escallops and queans are not, to my knowledge, taken in Ireland in any contaminable area, except in the case of the

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former, in Cork Harbour, and these shell fish are well cooked before reaching the table.

In the case of all molluscs which are stored alive for purposes of sale, it may be suggested that there is a possible source of contamination with which sewage has nothing to do, viz., by the imbibition of water contaminated by the decomposition of the organisms which commonly grow on their shells.

It is possible that in some instances "poisoning," popularly attributed to sewage, may have been due to this cause.

Considerations in Determining Whether Shell fish are Contaminated by Sewage to an Extent which Should be Regarded as Dangerous.

It appears to me that in this matter one must be largely guided by the report of the expert bacteriologist, who is accustomed to take such matters into consideration.

Personally, in the case of an oyster bed remote from any sewage outfall, as is the case in the vast majority of Irish beds, I should not be disposed to consider the presence of bacillus coli communis in small numbers as of any importance. I think the geographical position of the bed, in regard to sewage outfalls, should always be taken into consideration, as should also the local practice of dumping oysters while awaiting sale. Occasionally one finds that oysters which have been dredged from ground beyond reach of contamination are brought up and dumped for longer or shorter periods in places contaminated by human resort, and although the risk of the introduction of dangerous matter is small, the circumstance must to some extent be taken into account. Regular storage pits, in which objectionable matter might remain for a prolonged period, are not in general use (if at all used) in Ireland.. Probably sufficient pressure could be brought to bear to induce fishermen to select dumping grounds with due regard to sanitary considerations.

In the case of oyster beds not remote from sewage outfalls where samples yielded bacilli only in unimportant numbers, I should be disposed to pass the bed as safe, but would have samples inspected at frequent intervals in case any change in condition might arise.

General.

In the case of Ireland, with very few exceptions, the grounds which are now, or have been in the past, productive of oysters, or successfully used for oyster culture, are remote from any possible source of sewage contamination, and the problem is not to prevent pollution, which is most unlikely to occur, but to assure the public that the oysters which they may purchase as from these unpolluted areas, are really derived from them.

If this could be effected either by means of certificates and legislation on the lines which I have already suggested, or by any method which may appear more satisfactory, the development of the industry on our coasts might compensate for its restriction on grounds which may prove incapable of purification, and it is not impossible that something may be done in the way of isolation of good quality oysters even from remote centres of production.

Two difficulties have hitherto beset persons who have sought to re-establish the industry on our coasts—first, the difficulty in securing a market, and, when this has been accomplished, the difficulty of securing a sufficient stock from the native beds. The natural beds have greatly suffered from over-dredging, and some of them are now practically exhausted.

Steps have been taken by the Department to prevent over-dredging of the Tralee bed, now the most important of those which produce oysters for re-laying, while the Clarenbridge dredgers voluntarily restrict their operations to a few days a year.

For the last two years the Department have made experiments with a view to test the value of seed oysters imported from different centres of production abroad for Irish culture, as also of English oysters from different places. Methods of spat production and of culture generally are being tried, and it is hoped that it may be possible to devise a system suitable for adoption as a secondary industry by small farmers. Supervision by the Department with especial regard to the purity of the beds would be an essential feature of such an industry, and it should be possible to get the oysters marketed with absolute certainty to purchaser of their origin.

In regard to legislation, it may be remarked that Irish fisheries have hitherto been dealt with in Acts which do not apply to the rest of the United Kingdom, and that any departure from this system might give rise to serious inconvenience, or would at least gravely increase the difficulties of drafting subsequent Acts.

LICENCES TO PLANT OYSTER BEDS IN IRELAND.

Granting of Licences.

The Department of Agriculture and Technical Instruction for Ireland can grant licences to the following persons for oyster beds above, or above and below low water mark :—

1. The owner of a several fishery.
2. The owner of the soil and bed of an estuary.
3. The owner of land bordering on the sea or an estuary.
4. The occupier of land bordering on the sea or an estuary during his continuance in occupation.
5. Any person, with the consent in writing of an owner of land bordering on the sea or an estuary, for the period named in the consent of such owner, with the approval of the Lord Lieutenant.
6. Any person, with the consent in writing of an occupier of land bordering on the sea or an estuary, during the continuance in occupation of the person who was in occupation at the time of the granting of the licence, with the approval of the Lord Lieutenant;

and to any person can grant a licence to form a bed exclusively below low-water mark, without any consent from the owner or occupier of the adjacent lands, but subject to the approval of the Lord Lieutenant.

(*Specimens of application forms annexed.* See *pages* 227–8.)

Licences may be made subject to such conditions and limitations, and may be perpetual or terminable, as to the Department shall seem proper.

No licence can be granted in any place where the Department shall be of opinion that the public exercise and enjoy *bonâ fide* a sustantially profitable fishing for oysters, nor within the limits of any oyster bed or oyster fishery, the property of any private person.

Steps to be Taken Before Granting a Licence.

Previously to granting a licence, a notice, stating the application and the time and place (not sooner than three weeks from the date of such notice), when and where the Department shall hold a public inquiry in the district, as to the expediency of granting the licence, is to be inserted at least three times in some newspaper circulating in the district; and also to be posted at or near the nearest police station.

Any person feeling dissatisfied may appeal *within one month* after the granting of the licence, by way of memorial to the Lord Lieutenant in Council, that the licence may be vacated; and notice of such appeal must be given to the licencee and to the Department. The Lord Lieutenant in Council adjudicates thereon, and either confirms or vacates such licence.

Revocation and Determination of Licences.

If the Department are of opinion that the licencee has not, within three years from date of licence, taken proper steps to form the oyster bed, they can, upon giving due notice to the person entitled to the licence (or in case such person cannot be found by causing such notice to be inserted as an advertisement three times at least in some newspaper circulating in the district), and after waiting one month from the date of the sending of the notice (or from the date of the last advertisement), revoke said licence.

If the Department are satisfied that the licencee is not properly cultivating the oyster ground within the limits of the licence, they can, by certifying to that effect, absolutely determine the licence.

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DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND.

OYSTER FISHERIES.

62 & 63 Vict., c. 50 ; 32 & 33 Vict., c. 92, and the Acts incorporated therewith.

Application for Licence to Plant Oyster Beds exclusively below Low-water Mark.

I[a]

of[b]

Post Town, County of

being desirous to avail myself of the right to form and cultivate Oyster Beds in[c]

in the Parish of Barony of

and County of in the place coloured blue on the Ordnance Sheet sent herewith, do hereby request you to grant me the necessary Licence in writing, pursuant to the provisions of the above-named Acts, to form or plant such Oyster Beds.

I state that the place in which I propose to form such Oyster Beds is[d] situated in a several Fishery,[e] *and I forward herewith the consent in writing of the Owner of such several Fishery, to my Planting such Beds.* I further state that in the place I propose to form such Beds, the Public do not exercise and enjoy, *bona fide*, a substantially profitable Fishing for Oysters, nor is the place within the limits of any Oyster Bed or Oyster Fishery the property of any Private Person.

Dated this day of 19 .

Signed,

To

The Department of Agriculture and Technical
Instruction for Ireland,
Fisheries Branch,
Dublin.

NOTE.—This application must be accompanied by a Townland Ordnance Sheet (6-in. scale), on which the precise limits of the proposed Oyster Bed must be clearly delineated by blue colour, and signed and dated by the Applicant.

[a] Name in full.

[b] Residence in full.

[c] State exact particulars whether in the Sea, or any Estuary, Bay, or Lough.

[d] If not in a several Fishery insert the word "not."

[e] The lines in italics may be scored out when the proposed Beds are not in a several Fishery.

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OYSTER FISHERIES.

62 & 63 Vict., c. 50 ; 32 & 33 Vict., c. 92 ; and the Acts incorporated therewith.

Application for Licence to Plant Oyster Beds on Shores above or above and below Low-water Mark.

[a] Name in full. I[a]

[b] Occupation. [b]

[c] Residence in full. of[c]

Post Town,

County of

being desirous to avail myself of the right to form and cultivate Oyster Beds on the Shores adjacent to

off the Townland of

in the Parish of Barony of

and County of in the place coloured blue on the Ordnance Sheet sent herewith, do hereby request you to grant me the necessary Licence in writing, pursuant to th provisions of the above-named Acts, to form or plant such Oyster Beds.

I state that I am[d]

and [e]*not being the Owner or Occupier of said Lands, or the Owner of a several Fishery, I forward herewith the consent in writing of the*[f] o

such[g]

and I further state that, in the place I propose to form such beds the public do not exercise and enjoy, *bona fide*, a substantially profitable fishing for Oysters, nor is the place within the limits of any Oyster Bed or Oyster Fishery the property of any Private Person.

Dated this day of 19 .

To

The Department of Agriculture and Technical
Instruction for Ireland,
Fisheries Branch,
Dublin.

NOTE.—This application must be accompanied by a Townland Ordnance Sheet (6-inch scale), on which the precise limits of the proposed bed must be clearly delineated by blue colour, and signed and dated by the Applicant.

[d] State whether or not applicant is Owner of a several Fishery or Owner of the soil and bed of the Estuary, or Owner or Occupier of the lands bordering on the Sea or Estuary where it is proposed to plant the Oyster Bed.

[e] The lines in italics may be scored out where the application is made by the Owner or Occupier of Lands, or the Owner or Occupier of a several Fishery.

[f] If in a several Fishery, the consent of the "Owner," and if not in a several Fishery, the consent of the "Owner" or "Occupier" of the Lands must be forwarded.

[g] "Lands" or "several Fishery," as the case may be.

19579*. (*Chairman.*) In this paper that you have given us you have made some very valuable suggestions as to the issue of certificates of non-contamination of shellfish, and you have mentioned the period for which you think such certificate should remain in force. Now, might I ask you whether you think it would be possible to brand the shellfish with the place of their origin?—The actual shellfish?

19580. To brand the shellfish with the place of their origin—consignments of shellfish?—Oh, consignments? It is a thing which dealers can, of course, do for themselves, but I believe it would be utterly impossible for a Public Department to undertake the duty. The places where these things are produced are scattered all over the country. In some places there are important fisheries, in others they turn out perhaps 200 or 300 oysters and a bag or two of mussels in the course of the year, and the cost of branding would be exactly the same whether the place possessed a valuable fishery or not. It is not a matter with which I have to do myself, but I understand that there are very serious objections to the branding system.

19581. Do you think that in the case of a polluted breeding ground it ought to be closed by some authority?—I consider that if the breeding ground is found to be dangerously polluted the sale of oysters from such a place for direct consumption ought to be interfered with. But as a rule, so far as Ireland is concerned, in these breeding grounds, with the exception of Carlingford Lough, the vast majority of the oysters that are sold are not fit for immediate consumption, and are not used for it; they are sold to relayers and put down in other beds. Carlingford Lough is an exception, because it is both a breeding ground and a most valuable fattening ground, producing excellent oysters ready for consumption. Cork Harbour perhaps also produces to a less extent good oysters, being itself a natural ground.

19582. Where an oyster is, so to speak, put into quarantine, have you any idea as to how long a period of quarantine is necessary?—I have no original observations; I am not a bacteriologist, but I gather from the writings of Professor Klein and others that a fortnight is about the period it takes an oyster to get rid of any germs it may happen to have about it.

19583. You mention a fortnight on the authority of other people; not as result of original observations?—Exactly. I do know that a longer period of isolation does not do the oyster any harm for commercial purposes.

19584. You say in your paper that in China you have heard of oysters being turned into intentional contact with sewage, and that they thrived well?—Well, I really have very little information upon that subject. I have heard it, and I believe it is the case, but I have never been on the ground.

19585. You have no idea as to whether any disease has ever been caused by such oysters in China or not?—No. I know nothing about that.

19586. Then you say the dangerous bacilli do not, as the Commission is aware, breed in the oyster as they do in the cockle, but have you authority for saying that dangerous bacilli do not breed in the oyster?—I thought that was the general statement of bacteriologists who had studied the matter, and I thought you would probably have had evidence on that subject.

19587. But there again you only speak on the authority of others?—On all matters relating to bacteriology I only speak on the authority of others.

19588. Now, supposing that there were legislation on this subject of shellfish, should you consider that it would be desirable to have a separate Act for Ireland, or that one Act for the whole of Britain would do?—The Irish fishery legislation has always been separate from the English and Scotch legislation, and I believe that it is considered that it would be convenient that it should remain so. I fancy great difficulty would arise in the case of the drafting of subsequent Acts. Constantly Acts are passed which are read with others, as the expression is. I think it would be very difficult to separate those which are intended to apply to Ireland and those which are not.

19589. Then you would, in fact, prefer a separate Act for Ireland?—I speak, of course, entirely as a private individual in a matter of that sort, but it seems to me that it would be most convenient for the general purposes of fishery legislation.

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19590. (*Sir Michael Foster.*) Public health would be adequately protected, would it not, Mr. Holt, if in granting a licence to plant oyster beds care were taken that the beds so licensed should be free from sewage contamination? At present the licence, I understand, does not take that point into consideration at all?—I think pollution is not mentioned at all in any of our Acts relating to oyster fisheries, no doubt, because at the time when the Acts were passed the possibility of communication of disease by oysters was not dreamed of.

19591. But that would be quite possible, would it not, to make the granting of the licence conditional on the place being free from contamination?—It is a question, I think, whether it would be possible to deal with the licence in that way under existing legislation. Of course, if the law were altered so as to enforce consideration of that matter in the granting and withdrawing of licences, the matter would be simple. But I should rather not express an opinion as to whether in the present state of the law such matter could be taken into consideration at all.

19592. Of course, the prevention of disease from the oyster beds is a sanitary matter, is it not?—Yes.

19593. And, therefore, naturally would fall within the sphere of a sanitary authority rather than a fishery authority?—You mean, sir, the prevention of the sale?

19594. Yes; or I mean, for instance, supposing legislation were brought about for the granting of licences only on sanitary conditions—that is to say, free from contamination—would not the granting of those licences naturally fall into the hands of the sanitary authority rather than the fishery authority?—As the fishery authority possesses every other power in regard to the granting of oyster licences and to the control of fisheries generally, it would seem most convenient that any additional powers should be vested in the fishery authority.

19595. On the other hand, the sanitary authority would have all powers concerning all sanitary matters, and therefore would it not be reasonable that they should have sanitary powers over oysters as well as other things?—Over oysters in the market?

19596. No, oyster layings, and so on. Would not the fishery interests be adequately secured if the fishery authorities or the fishery interest had the opportunity of making representations, or, if necessary, being represented on sanitary authorities dealing with oyster beds and the like?—I believe, sir, it is more a matter of convenience than a matter of principle.

19597. Well, as a matter of convenience, would it not to be so?—It appears to me that as the officers in whom such powers are vested can absolutely cancel a licence on certain grounds——

19598. But the judgment as to whether a laying should be closed on sanitary grounds is entirely a sanitary matter; and, therefore, should be handled by a sanitary authority. However, as you say——?—It is a matter of convenience solely, I think, sir.

19599. Do you not think, supposing oyster beds and oyster layings were licensed under the conditions that they were free from contamination, and that it was made illegal to sell oysters for consumption as food from any other source, that that would be adequate protection without any trouble about certificates or branding and the like?—Such legislation would of course have to embrace not only the licensed beds, which are a comparatively small proportion, but also the chartered beds, over which the Fishery Authority have no control, and the public beds.

19600. Oh, it is all beds?—And also, I suppose, oysters that might be imported from abroad.

19601. Yes, they would have to be taken into consideration, too, but I mean if it were illegal to sell for consumption oysters other than those taken from beds or from layings which were guaranteed as free from contamination, or, if imported, had been placed under such circumstances that they were free from contamination, then that surely would be sufficient safeguard for the public health?—Yes, provided you could guarantee that the oysters had not been taken from a polluted bed and put for a day on an unpolluted bed and then sold as from that last bed.

19602. Yes, but a prosecution would meet that difficulty, would it not?—I think it would be rather difficult to make sure that the law was not evaded occasionally.

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19603. But can you make sure in any case that the law is not evaded?—I do not know.

19604. If any person, I mean, were liable to prosecution for selling under false pretences oysters?—Yes, if it were made quite clear that any evasion of the spirit of such legislation was an offence against it, there would be very admirable protection of the public.

19605. (*Colonel Harding.*) I should like to ask you, in reference to one paragraph in your interesting paper. You say that the Commission is aware, or you presume that the Commission is aware, that, so far from being harmful to the oyster, a certain amount of sewage is actually beneficial. Do you know of any evidence bearing on the beneficial character of sewage to oysters? That is to say, of any case where oysters are deliberately put in the midst of sewage contamination for the purpose of fattening them?—There are many cases in which oysters are laid in estuaries which are known to be very largely contaminated, and in which the oysters thrive exceedingly well.

19606. Is there any evidence on that particular point? Because, so far as I remember, no evidence of that character has come before us. We have visited a number of fattening beds which were quite distinct from any possibility of sewage contamination, and in which it was pointed out to us that the oysters were very fat and plump, and altogether satisfactory for the market, and it is something new, at least, to me, to learn that the presence of sewage is in this way beneficial to oysters. What evidence have you upon which you form this opinion?—Well, in the case of Carlingford, which appears, from what I have heard Professor McWeeney say to-day, to be at least under strong suspicion of sewage contamination, the oysters are of exceedingly good quality, and compare most favourably with natural oysters of many other parts of the country, which are quite free from that. I do not wish to imply that sewage itself is a matter of great benefit to the oyster.

19607. It has a sort of secondary influence that it promotes the growth of diatoms and other foods which are the natural food of the oyster?—Exactly.

19608. You make a statement further, that in China you understand oysters are intentionally fed with crude human ordure, and thrive thereon excessively. What is the nature of the evidence for that statement?—The evidence that I have is merely hearsay. I said I understood that such was the case. I thought possibly your Commission might be in a position to obtain more exact information on the subject.

19609. You are unable to lead us to such evidence?—I tried to find further positive information on the subject. I believe it is the case, but I cannot produce absolute statements on the subject.

19610. (*Sir Michael Foster.*) You cannot refer to any publication?—No.

19611. (*Colonel Harding.*) Then, although you make the statement that you believe that in certain cases the presence of sewage has assisted in the fattening of oysters, you have no doubt, have you, in your mind that the presence of sewage is an element of danger to the oyster eaters?—Oh, that, of course, is absolutely certain.

19612. You have no doubt about that?—I have no doubt on the subject whatever.

19613. And your suggestion that, rather than close certain layings which are of great value to the fishermen of different districts, it would be better to lay down a regulation that oysters from doubtful layings should be relaid in safe positions; you think it is quite a practicable remedy?—I think it is the only possible remedy. It seems a great pity that the fisheries that are dependent on these somewhat polluted beds should be absolutely closed.

19614. And you do not think, do you, that the removal of oysters and the relaying of them for a period, say, of a month, such as you suggest, would be fatal to that particular oyster industry?—No; I have examined oysters from Carlingford, supposing Carlingford to be polluted, that have as matter of fact been laid for a month in an absolutely clean bed in the West Coast, and they still were very good oysters—better, or quite as good, as the best of the natives.

19615. (*Sir Michael Foster.*) In your paper I think you give us a pretty clear statement as to the method of granting licences?—I handed in a statement that was prepared in the office for the Administrative officers who are concerned in the matter.

19616. Yes; that we may take as the method adopted in the granting of licences?—Yes.

19617. And I understand that in granting the licence no heed whatever is taken of sanitary conditions?—I should not like to say that, but I do not see in the Acts any provision for such heed.

SIXTY-SIXTH DAY.

Thursday, 5th November 1903.

PRESENT:

Sir WILLIAM RAMSAY, K.C.B., F.R.S. (*in the Chair*).

Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E. | Mr. W. H. POWER, C.B., F.R.S.

Mr. F. J. WILLIS (*Secretary*).

Also Present:

Dr. A. C. HOUSTON. | Dr. H. T. BULSTRODE.

Mr. J. WRENCH TOWSE, the Clerk of the Fishmongers' Company, called in, and Examined.

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(*Mr. Wrench Towse.*) You have a copy of what I have here. I shall be very pleased to give you all the information I have, but I should prefer that most of it should be taken as confidential.

19618. (*Chairman.*) Of course you will have a copy of the proof later on which you will correct as you wish. Perhaps I may take you formally, and say you are the Clerk of the Fishmongers' Company?—I am.

19619. You exercise, do you not, a certain amount of control over the selling of fish in London?—Yes, in accordance with the authority of our Charter of 2nd James I.

19620. Which means not merely shellfish but all fish?—All fish.

19621. That refers to Billingsgate Market, I presume?—London and suburbs.

19622. Have you inspectors to go round and report?—Yes.

19623. And these inspectors bring you samples of the various fish which is sold, or do they judge themselves as regards the fish?—Well, they judge themselves. Of course, in cases where they are in doubt they appeal to me.

19624. And they bring samples to you?—Yes.

19625. Which you then submit to some specialist?—Yes, shellfish.

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19626. Shellfish ?—Yes.

19627. Then do you find that you often have to take action in the matter ?—Lately, yes.

19628. Since the oyster scare ?—Since the oyster scare. I may say that prior to this last scare we commenced to make inquiry of the various oyster layings around the coast, and unfortunately the scare at Emsworth arose, and then we took more drastic measures to endeavour as far as possible to prevent the sale of such oysters as we found upon proof--that is to say upon analysis—to be polluted.

19629. Have you any control of the oyster beds ?—None at all.

19630. In judging of the shellfish as regards their contamination, do you trust entirely to bacteriological evidence ?—No, certainly not. We take into consideration the surroundings.

19631. You send inspectors to examine the spots ?—Yes. It is not necessary to occupy all your time, but these are the reports of inspectors. (*Exhibiting bundle of papers*).

19632. Of the various oyster layings which they have examined ?—Yes.

19633. You get a clue to the contamination of the shellfish, I suppose, by the samples you obtain from Billingsgate Market ?—Not always, sometimes there, but sometimes we know where these beds are, and we look at the surroundings, and we think it is desirable that these shall be inspected first, before the sale is allowed to be continued.

19634. Do you ever condemn shellfish without knowing where they come from ? Do you sometimes act on a bacteriological examination alone ?—No, I cannot say that we know from whence all these fish come ; we can easily ascertain.

19635. Are you troubled with foreign shellfish ?—Yes, we have some from Holland ; not so much, of course ; there are the French oysters, but they are generally relaid, and mussels.

19636. Mussels, too ?—There have been very serious questions both in regard to cockles and mussels during the last few months. Practically they are all polluted, and we have been considering how we can allow these to be sold, and yet have the public health protected, and we have been experimenting. I may say for some months past I have been endeavouring to get the Leigh cocklers to be more cleanly in their habits, and also to boil the cockles for a longer period. Usually they boil them only sufficiently long so that the fish come readily away from the shell.

19637. We have seen that ?—Well, just recently within the last ten days, we have tried to see whether steaming would be more efficacious than boiling, and we find that if the cockles and mussels are steamed for five minutes they are absolutely sterilised, and in that condition we consider that they are fit for consumption.

19638. Then in the case of cockles and mussels you obviously rely upon bacteriological examination ?—Yes.

19639. And have bacillus coli been found ?—Yes.

19640. And other sewage organisms ?—Yes, and streptococci and enteritidis sporogenes.

19641. Do you consider that the grounds, I suppose in the neighbourhood of the Lee, at the mouth of the Lee where these cockle and mussel beds are, are polluted ?—Sewage is passing over.

19642–3. (*Major General Carey.*) On the flood as well ?—Scarcely is the ebb over before the young flood commences, and it curls in here, round these points here, and gradually fills up here to Hadleigh Ray and higher, and therefore it has not got the young flood, but nevertheless, after a while all this portion is covered.

19644. (*Chairman.*) Then you do not trust to bacteriological examination alone, I think ?—No, not entirely.

19645. Simply by an examination of the grounds ?—Simply the physical circumstances of the surroundings.

19646. And you find that the two pieces of evidence corroborate each other ?—We do.

19647. I see you have a large number of investigations by Dr. Klein ?—Dr. Klein has analysed all for us.

19648. All ?—Yes.

19649. Can you take legal proceedings ?—No.

19650. You speak of legal proceedings being under consideration by the Cleethorpes Council ?—That is a case which is now pending. The Cleethorpes oyster beds were condemned by us, and we wrote to all the oyster planters saying that we could not allow any of these oysters to be sold in the London markets, and we gave notice to the Medical Officers of Health for Sheffield, Cleethorpes, and Grimsby and other bodies, etc. One of the planters, we understood, notwithstanding that notice, continued to sell. I wrote down to the Medical Officer of Health, informing him. One of the Company's officers purchased some of the oysters and the Local Sanitary Inspector, obtained a magistrate's order to destroy them, and upon that, in accordance with the terms of the Public Health Act, he applied for a summons That summons was made returnable ; I do not know what day, but no doubt it is within the next few days now ; and I hope that this will be the first case under the Public Health Act. I was told incidentally the other day by a member of the Cleethorpes Council that the Town Clerk and others feared that the law was scarcely strong enough, and probably they would fail. I said nevertheless "go ahead, if you win, you will set the Public Health Act in motion. If you fail, it shows that it is not strong enough, and therefore it will do good either way. So far as I know, they are persisting in this case, and this is the first case that we have yet been able to, or the company have yet been able to get through. We had a case in Colchester, Wivenhoe, which you will see somewhere here, where a similar action was taken, and a summons granted and the day it was made returnable, they withdrew from the case on condition that the merchant closed the pit whence the oysters were taken and paid the legal expenses. We pressed hard, and offered to pay expenses, but we could not get them to go on. And then I complained to the Local Government Board, and wrote to them, and they wrote down rather a stringent letter, but to no effect.

19651. But what is the ultimate appeal, supposing a fish merchant in London insists upon selling diseased fish ?—We have absolute power in London of seizing.

19852. You seize ?—Absolutely, we have drastic powers under our Charter, but we cannot prosecute. There is no question if we consider the fish unsound, unfit for food ; we say so, and take it and destroy it. We contract with a manure contractor to take the fish away from Billingsgate Market. Before putting it into his barge, we put carbolic acid on it.

19653. So as to disinfect ?—So as to absolutely destroy it.

19654. (*Major-General Carey.*) How do you decide whether it is unwholesome for food ?—If fish, of course, the appearance of the fish. There are various indications showing there is no doubt about that. The appearance of the bone, or the eyes, or the nature of the fish generally. In regard to shellfish, of course, we should probably have to go to Dr. Klein first. If we know that it comes from a bed which we consider polluted, we should say "You must not sell this until we get a bacteriological examination." And if that analysis and examination prove that these are unpolluted, we allow them to be sold ; if not, we issue an order. But we have said this, "we know these are from a polluted source ; we do not think it is necessary to have a further analysis taken : if you take our advice, you will return them to the beds ; as we shall not allow them to be sold. If you do return them we shall not seize, but if you do not guarantee to return them we must take them."

19655. (*Chairman.*) And they take your advice as a rule ?—Yes, we are careful not to go too stringently to work. That is to say, we like to be absolutely sure of our facts before taking action, because we should not like at any moment to be upset as it would do us a great deal of harm, apart from the loss to the others. Therefore, we rather err on the right side.

19656–7. On the side of leniency ?—On the side of leniency.

19658. You have, of course, no control over the beds : have you any views as to what control should be exercised? —I think it is useless to allow the local authorities to

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have any control at all; because in one case they would exercise it unfairly—unduly—and in another case they would be too lenient, because in all probability they would have an important man, I may say a man of some means, owning these beds, on the Council, and of course they would not dare to go against him. In the other case it might be that this man had a grudge against a man who is not on the Council and who was not in such a position, and he would go for him, or rather he would intimate to the Council that it would be desirable that action should be taken against B. C. Therefore, I do not think that would work. Besides which, until it is proved to the contrary I think the Public Health Act is sufficiently strong if made operative by the various local councils. But the Medical Officer of Health again is in that position that he dare not move. It is all very well for him to seize a leg of mutton, and so on, where he can see that it is absolutely bad, or milk, but when you come to shellfish it means a very big undertaking, and he does not like to place himself in what I might say is an invidious position, especially with a local council.

19659. Supposing the authority were made sufficiently large so that it was not directly connected with the place where the layings were—such an authority as the Rivers Board—would that get over the difficulty?—I think so, because any officer that they might appoint would be independent.

19660. He has no local connections?—He has no local connections, and if I may be allowed to say so, he would be independent of his own Board. He would be a man in a position of authority, otherwise you would not appoint him; therefore, you place him in a responsible position, and his duty should be to administer the directions of the Board, and, therefore, if he carried out his duties properly a large board could not interfere with him—could not, and would not.

19661. (*Major-General Carey*). You can condemn the supply of oysters delivered in London on the grounds that they are unwholesome—unfit for food—but what control do you exercise over the supply coming from a known polluted source?—Now, if you will allow me, I will take cockles as an instance. For instance, for eight months we have been endeavouring to get the cocklers, as I mentioned incidentally just now, to come to some arrangement by which they could boil the cockles for a definite period. We had our doubts, but it was only about a fortnight or three weeks ago when they were confirmed. A sample of these cockles was taken on a Saturday; they were analysed by Dr. Klein, and found to be practically raw. We had known previously that a large quantity of them had been relaid in the Leigh Creek, which is known to be polluted with sewage. We sent down a notice to the effect that we would not allow any cockles to be brought into London, and for the last fortnight they have done nothing at all—absolutely stopped—and in the meantime these men have nothing to do. They are in a terrible state, and Dr. Klein and I and others are endeavouring to see if there is not some remedy; and we ascertained that steaming is better. I saw the Rev. Stuart King and three or four cocklers to-day, and they are going to consider the matter whether they will either combine or apply to the local council to erect a boiling house in order that they may go on. Dr. Klein said if the cockles were absolutely sterilised there would be no harm in their being sold to the public. In regard to oysters where the beds have been polluted we have written to the various owners informing them we would not allow them to be sold in London, and if we have heard that they have been sent elsewhere we have written to the authorities cautioning them against their being sold.

19662. (*Chairman.*) What do you mean by "If they have gone elsewhere?"—If they have gone to another market.

19663. (*Major-General Carey.*) Another locality or other towns?—Another locality or other towns, yes.

19664. (*Chairman.*) Are you troubled with the possibility of oysters from a polluted part being sent elsewhere, and then sold from that other place?—Oh, yes; they may do that; and probably, we do not know it, it is being done now; but the oyster merchants generally agreed some months ago to act entirely upon any advice the Fishmonger's Company might give. There was a formal resolution passed, and they have generally loyally abided by it.

19665. Is that to their advantage or their disadvantage?—Their disadvantage in this sense, because if we condemn them, they will accept our discretion.

19666. On the other hand, if you do not condemn them, it is a kind of recommendation?—It is a kind of recommendation that they are all right.

19667. You have read our third Report, have you not?—I think so. Mr. Willis kindly gave me a copy.

19668. It recommends, you know, the appointment of Rivers Boards?—Yes.

19669. And you would agree with that recommendation?—I think that recommendation is as good as I have heard, or I could suggest.

19670. Do you consider the duty of the Rivers Board is to superintend the whole condition of the rivers in the watershed?—Yes.

19671. And to exercise control, not merely as regards sewage pollution, by the various towns on the banks, but also control over the estuaries, so far as it is necessary?—Yes, I conclude that that Board would deal fairly between the various parties; that is to say, the parties infringing—pouring sewage into the rivers—on the one hand, and the oyster merchants on the other. Of course, it is a very difficult thing, and it is just the same in London. The London sewage is polluting the Thames to an enormous extent. The London County Council may say, "Well, you are aware that to alter the sewage in London would cost millions; we cannot afford it; therefore the oyster merchants must go." Still, of course, the oyster merchants have a very large undertaking, and is it right to ruin them to save themselves?

19672. There would, of course, be a right of appeal from such Rivers Boards to a central authority; that is also recommended?—Yes; the right of appeal seems to me a very proper proviso to insert, but in any question of closing a bed, it is too cumbersome. I think. You can provide for it, but if the bed is to be closed, it must be closed at once; you should not allow it to go for even two or three days. You may have an outbreak of typhoid in a certain area, and you have known previously from inspection or otherwise that the sewage is passing through certain oyster beds. Well, then, you know at once that the means of perpetuating and increasing the illness is going on.

19673. I think the position of affairs would be this, that if the Rivers Board were to condemn any beds their decision would be like an interdict?—Yes.

19674. Which would bring about an immediate closing of any polluted districts, but the decision could be appealed against, and they might ultimately be retained?—All you mean is, they might be absolutely closed for the time being.

19675. For the time being, until the appeal was settled?—Quite.

19676. And the nature of the peremptory order would be such, that very quick action would take place; there would be no undue delay, as in the ordinary Law Courts, between the closing of the bed and the appeal, so that there would be no particular hardship inflicted upon the oyster merchant?—Oh! not in that case.

19677. (*Major-General Carey.*) Do the company try to exercise control over oysters supplied from abroad—or any kind of shellfish?—Oh! yes; in the case of mussels, of course, we cannot prevent the landing, but we say, "They are coming from a polluted source; you must not deal in them"—so we stop them. Now, in regard to Portuguese, early this year we ascertained that most of the Portuguese were polluted to a considerable extent, and even where they were in close proximity to native oysters which showed no pollution. We could not understand this at all, and we have not thoroughly threshed it out yet; but in the meantime, I wrote to the merchants and consignees, recommending that until we had come to some decision, with regard to the Portuguese, it would be desirable for them, in their own interests, not to import any more, and our advice has been generally acted upon. It is a singular thing that in regard to the British born, Portuguese, they have been found to be quite pure or unpolluted, and the native Portuguese, or those that come from Ile de Ré—I think Arcachon and the Heron Island too, and relaid here; they show some pollution.

19678. Pollution is ascertained by bacteriological analysis?—By bacteriological analysis.

19679. (*Chairman.*) The Portuguese oyster, of course, has a curious shape?—Has a curious shape, and the question is whether they have the power of cleansing themselves. It has been proved that a flat oyster is capable of cleansing itself within, or not extending over 20 days. That we have tried naturally; that is to say, we have taken oysters from Cornwall, from a polluted area, and placed them in water which was known to be pure, and they have come out at the end of 20 days perfectly unpolluted. At the first seven days they showed an improvement; and the 20 days (we did not analise in the interval) there was no pollution. That clearly demonstrated the fact that they were capable of cleansing themselves.

19680. We have had evidence to much the same effect before, but only in general terms. Could you procure for us the specific case; I mean the report on this particular case?—Yes.

19681. We should be very much obliged to you if you would?—It was a case of Mr. Fox. He is a gentleman whose oysters were bad, and he put them down on his own bed on the east coast; but I will give you the facts.

19682. (*Dr. Bulstrode.*) Had they come from Flushing?—Yes.

19683. (*Chairman.*) We should like very much to have that definitely in evidence, because it has been often stated that that has been so, but I do not think that we have any evidence to that effect?—Yes.

[COPY.]

No. 39.—Oysters from Flushing, Falmouth, taken on 3rd February, 1903. Professor Klein reports:—"Extensive pollution, nearly every one has B. coli connunis."

No. 95.—Native oysters from layings, Stangate Creek. These oysters were taken from this firm's layings at Falmouth and relaid at Stangate Creek for a week. Taken 19th March, 1903. Professor Klein's report:—"One of eight contains B. coli communis."

No. 98.—Native oysters from layings, Stangate Creek. These oysters were taken from this firm's layings at Falmouth and relaid at Stangate Creek for 20 days. Taken April 1st, 1903. Professor Klein's report:—"None of these oysters contain either B. coli com. or B. enteritidis sporogenes."

19684. (*Dr. Bulstrode.*) The reports of Professors Herdmann and Boyce, and also Dr. Klein, to the Local Government Board, but in none was that result absolutely obtained

19685. (*Chairman.*) Yes, it would be very valuable, I think, if you would?—All these experiments were laboratory experiments, were they not?—Professor Herdmann's were, I think. (*Dr. Bulstrode.*) Yes.

19686. (*Major-General Carey.*) As to the Cleethorpes oysters which were sent to Sheffield; how did you ascertain that they were polluted?—Our own officer went down; here is a statement of the Cleethorpes oysters on pages one and two. These were taken by our own officer and brought up to town and taken direct to Dr. Klein.

19687. Several samples?—Yes, I think five, or six, or seven—American oysters, deep-sea oysters, Dutch natives; and oysters from the pit.

19688. (*Chairman.*) As regards foreign oysters; how would you propose to deal with those—to warn the salesmen in London that they are condemned by you?—Yes, but most of the foreign oysters are generally purchased to be relaid.

19689. But there are some that are not, I suppose?—Some are not. Well, then, in those cases we should warn the consignees not to import them.

19690. In the case of the American oysters there is a guarantee given by the American Government that they are from unpolluted layings?—Well, yes; but, of course, they are mostly relaid at Fleetwood and elsewhere.

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19691. Is there any similar guarantee given by the French and Dutch and Portuguese authorities?—Not so far as I am aware.

19692. Not that they are pure?—No.

19693. In the case of those that are not relaid, you simply suggest that they should not be sold?—Certainly, if there be any doubt.

19694. Forbid their sale, as a matter of fact?—Yes.

19695. As regards other shellfish, how do you distinguish between mussels which are going to be used as food and those which are going to be used as bait?—I am very pleased that you have asked that question. There is great difficulty over that, and the only way that I can see any way out of the difficulty is this, that if they are cooked they should be cooked only on the one system, and that is by steaming for five minutes. If they are sold raw, then they ought to be sold on the distinct understanding that no guarantee can be given by the salesmen, and that a printed notice to that effect should accompany each parcel that is sold.

19696. That, of course, means wholesale?—Wholesale.

19697. But then you cannot expect the retail dealers to tell their customers that these mussels are polluted?—No, but I think in time we should be able to get the actual customers to have this notice in their shops. Of course it is a very big industry, and mussels are used as bait as well as for food, and I do not see at the present time how it could be stopped. You see, generally, mussels are cooked; even if they are bought raw they are cooked before being eaten by the people.

19698. (*Dr. Bulstrode.*) Only very insufficiently?—Very insufficiently.

19699. Just boiled?—Just boiled, which, of course, is not sufficient.

19700. (*Chairman.*) But are the shops the same, in which mussels are sold for bait and for food? I should have supposed that the mussels that are sold for bait would be sold in different shops?—Probably, but you say they all come from the same source.

19701. From the same source, precisely?—Yes.

19702. But there is no possibility of differentiating between them except insisting that they should be cooked?—That is all. There is a very large trade in mussels, but there is very little value in them, and I do not think it is fair to absolutely prohibit the sale. Use every means of precaution you can. Of course, if the public choose to eat a raw mussel they must put up with the risk.

19703. To revert for a moment to the question of holding the balance between the sewage authorities and the fish owners, General Rivers Boards would be made up of the representatives of the county councils of the counties who happened to lie upon their banks?—Yes.

19704. In the case of London it would be different. The London County Council owns its sewers. The representatives of many county councils cannot be said to own their sewers; that is to say, they own their own but not each others'; hence they could take a dispassionate view of the whole situation?—Quite. The London County Council is a very large body, and, therefore, I should say they would act impartially.

19705. You think it is probable they would?—Yes.

19706. The other counties do not own sewers at all?—No.

19707. But the London County Council does own its sewers?—Yes.

19708. You think there would be no need of any special legislation as regards London, because of that?—Well, there should be legislation if the Public Health Act is proved not to be sufficiently strong, but that we will see, perhaps, later on.

19709. After prosecution is decided on?—Yes, you see they have not acted at the present time. Dr. Murphy is a very energetic officer.

19710. Have you any experience as regards the point whether sewage effluent—that is the effluent after purifying—and treating sewage is as deleterious as crude sewage when it flows over oyster beds?—No, I have no evidence.

19711. (*Dr. Bulstrode.*) Do you think it would be possible to relay all the Dutch oysters; do you think

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the trade would take that pleasantly?—I think that would be almost too costly. But replying further to that, there is a case now in regard to French relaid at Hadleigh Ray. They have shown pollution, and we have told the owner that they cannot be sold. He said, "Well, what is to be done?" We said, "Can you move them anywhere?" "The expense is terrific; it is not worth it." I said, "It is either one thing or the other; can you not even move what you consider would be sold during the next few weeks, and let a fresh supply go to the pure beds from time to time? That would not be so costly." "Oh!" he said, "we will try it." And it is now about to be tried from Hadleigh Ray to Brightlingsea.

19712. Those are French oysters?—French oysters.

19713. Do you know the oyster merchants say it spoils the Dutch oysters to relay them?—No, I have not heard anything about that.

19714. Not all the American oysters are relaid, are they; about half and half, is it not?—The majority of them is relaid.

19715. The majority of those that are produced in certain months of the year?—Yes.

19716. But the rest?—Oh, quite so; they come into the market at once; yes.

19717. (*Chairman.*) Mr. Willis suggests that I should put to you that the Fishmongers' Company have spent a large sum of money in all these proceedings?—We have; we have spent a very large sum of money in paying for these bacteriological examinations—analyses. And then there are our own inspectors who have been moving about the country, and so on.

19718. You pay these inspectors; is that part of your duty as a Fishmongers' Company?—Well, you cannot say it is our duty, but under our Charter——

19719. You have the power?—We have the power.

19720. And I suppose you consider it your duty to exercise the power?—We consider it our duty, practically, to exercise that power; but we hope we are not going on spending at the same rate as we have been doing this year; it is rather too much.

19721. We are very much obliged to you for your kindness in coming to give us your evidence.

SIXTY-SEVENTH DAY.

Tuesday, 22nd December 1903.

PRESENT:

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P. (*in the Chair*).

Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, C.B., F.R.S.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT:
Dr. A. C. HOUSTON.

Dr. H. T. Bulstrode.

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Dr. H. TIMBRELL BULSTRODE, Medical Inspector of the Local Government Board, recalled; and Re-examined.

19722. (*Chairman.*) Could you kindly give the Commission a general idea of the circumstances under which outbreaks of shellfish-borne illness have occurred?—(*Dr. Bulstrode.*) Generally speaking, so far as I have been able to ascertain, in the vast majority of cases, where the evidence in support of the allegation has been strong, and where, moreover, the source or subsequent treatment of the shellfish has been carefully inquired into, such shellfish have been found either to have been procured from sources obviously liable to pollution or to have otherwise been exposed to contamination before consumption.

19723. Will you furnish the Commission with some illustrations in respect of outbreaks of illness alleged to have been caused by oysters, mussels, or cockles?—Yes, I have brought together some notes of such occurrences both in this country and abroad, and, without for a moment raising question as to the possibility of shellfish procured from places not at first sight obviously exposed to pollution, being potent for harm, I would venture to impress upon the Commission how much mischief might apparently be prevented were cases of obvious risk adequately and promptly dealt with. I would also accentuate the importance in all etiological inquiries of ascertaining precisely the sources and subsequent treatment of the suspected molluscs. The natural tendency of a shellfish vendor, when challenged as to the source of his wares, is to mention the most reputed bed or laying with which he is acquainted. An excellent illustration of this point was brought to my notice when investigating the outbreaks following the Southampton and Winchester mayoral banquets. I was told that oysters which had apparently caused a case of enteric fever at Ventnor had come direct from a bed which is relatively free from pollution, but, on pressing the point, and on examining the oyster merchant's books, it appeared that, although the statement as to the origin of the oysters was true, such oysters had been deposited for a time in ponds liable in a high degree to become specifically polluted. The instances which I now propose to put before the Commission, are not arranged in precise chronological sequence, nor are the notes in any sense to be regarded as a complete account of the history of shellfish-borne outbreaks, or as an expression of opinion relative to the evidence upon which the several outbreaks have been based. The notes are merely put together to illustrate the points above referred to.

OYSTERS.

America.

1. In the famous outbreak of enteric fever which occurred among the students of Wesleyan College, Middletown, Connecticut, U.S.A., in the autumn of 1894, the oysters which were shown to have been consumed at the banquet which was responsible for the outbreak—twenty-three cases of enteric fever, with four deaths—were procured in the first instance from Long Island Sound, but they had been brought for fattening or "plumping" purposes into a creek known as Quinnipiac River, where they were laid down within 100 yards from the outlet of the private sewer from a house in which, at the time the oysters were taken up for the banquet, there were two cases of enteric fever. (*See* page 152 of "Oyster Culture in Relation to Disease.")

19724. That outbreak was, I believe, the one which first drew public attention to the subject?—Quite so; but, as a matter of fact, the connection between shellfish and disease had been pointed out early in the nineteenth century*. The attention of the public was, however, not prominently drawn to the subject until this Connecticut outbreak was reported by Dr. Conn.

19725. Will you now give us some illustration of outbreaks in our own country?—Yes; I have made a collection of several cases.

England.

2. Dr. Newsholme, the medical officer of health of Brighton, has, as the Commission is fully aware, drawn attention for many years past to the large amount of the enteric fever occurring in Brighton, which he attributed to the consumption of oysters. These oysters were, at any rate, for the most part, procured from Southwick, where they were stored under conditions which rendered them obviously liable to pollution, specific and unspecific, by sewage. Concerning these ponds, I wrote as far back as 1895-6 that "the Southwick oyster ponds are in a most improper and unsafe position."

3. In 1897, Dr. J. M. Cook, medical officer of health for certain urban and rural districts in East Essex, reported to the Local Government Board that suspicion attached to oysters imported into his district from outside sources as having been instrumental in producing multiple cases of enteric fever. As a consequence of this information, my colleague (Dr. G. S. Buchanan), one of the medical inspectors of the Local Government Board, was instructed to make a comprehensive investigation into the circumstances of the outbreak, and he subsequently presented an exhaustive report to the Board upon the subject. This report is contained in the medical officer's supplement to the twenty-seventh annual report of the Local Government Board. The oysters in question were procured from Brightlingsea Creek, concerning which I wrote in 1895-6: "There can be no question as to the risk to which oysters deposited on the Brightlingsea foreshore are liable." Dr. Buchanan found the conditions practically the same in 1897, but they have, since the date of his inquiry, been improved.

4. On November 1st. 1897, Dr. Edward Sharp, Medical Officer of Health of the City of Truro, made a special report upon an outbreak of gastro-enteritis and enteric fever, which occurred after a supper party on October 5th, and at which raw oysters were partaken of, by some freely, by others sparingly, in consequence of doubts as to their wholesomeness. In all, seven persons partook of these oysters.

No. 1. was taken ill on following day with diarrhœa, and vomiting and general malaria, and on October 16th he was notified as suffering from enteric fever.

No. 2 felt unwell on October 11th, and was notified as suffering from enteric fever on October 27th.

No. 3 very ill on night of October 6th-7th with gastric fever and vomiting—soon recovered.

No. 4 did not consider oysters fit to eat, but took a few and suffered from diarrhœa.

No. 5 took a large number of oysters without inconvenience.

No. 6 had diarrhœa for a week.

No. 7 took three oysters, and next day had gastric fever and diarrhœa.

These oysters were taken from the foreshore at Malpas, and "the oysters laid down there were open to direct pollution by sewage from some of the houses in Malpas."

In "Oyster Culture in Relation to Disease" it states that "there can be no escape from the conclusion that oyster layings near Malpas and in the upper waters of the reach below it, must be liable to contamination."

5. In his annual report for 1899 Dr. Blamey, M.O.H. of the East Kerrier Rural District, reported on an outbreak of enteric fever (six cases, with one death) among the members of a shooting party at Carclew, and the illness was ascribed to the consumption of oysters stored off the Flushing foreshore. Only two of the six persons attacked were taken ill at Carclew; the remaining four took place in different parts of the Kingdom, and among persons who had taken a supply of Flushing oysters with them.

Again, in 1902, Dr. Blamey presented a special report to the East Kerrier Rural District Council as to an outbreak of enteric fever and other illness among the members of the officers' mess at Bodmin. All those who partook of oysters were attacked: those who abstained escaped. There was, presumably, as is so often the case in these shellfish outbreaks, mixed infection. The oysters, in this instance, were procured from the same source as those to which the Carclew outbreak was attributed, and this situation is, in my view, eminently unfitted for the storage of oysters. (*See* page 58 of "Oyster Culture in Relation to Disease.")

6. Dr. William Hoffmeister, Medical Officer of Health of Cowes, states in his annual report for 1901, when dealing with a case of enteric fever:—"All the sanitary arrangements seemed right. It seems the patient, aged 21 years, ate largely of oysters on November 9th ult., and was seized with vomiting next day, as were also both his parents, but to a much less degree, as they ate but a few. I am told that the oysters were bought from an East Cowes fisherman, being caught in the Solent, and at night were placed in a box sunk overboard, and remaining till the morning, the said box being within 15ft. to 20ft. of one of the East Cowes public sewers. I have acquainted the Medical Officer of Health of East Cowes of this. The fisherman denied the truth of these statements to the Medical Officer of Health."

As to this I can only say that the River Medina was, and, for all I know to the contrary, still is, used for the growth and fattening of oysters, and in that portion so used the sewers of both East and West Cowes empty themselves, as also higher up the estuary, does the effluent from the town of Newport. Several cases of enteric fever have been alleged to have been caused by oysters procured from this source, and I have myself dredged up oyster quite at the mouth of one of the sewers. Moreover, up to quite recently it was a common practice to bring oysters from some of the purest layings in England and to store them until wanted in a "float" within a few yards of one of the West Cowes sewers. This practice, in consequence of my repeated representations to the oyster merchant concerned, has now, I am informed by him, been discontinued.

6a. Dr. Elliston, Medical Officer of Health for Ipswich, in his annual report for 1900, furnishes an interesting illustration of the manner in which the public may be misled as to the origin of oysters.

Some fishing boats were found to be moored alongside the quay in the Ipswich docks, the boats being arranged as oyster stalls on which were displayed placards bearing the inscription, "Oysters, 6d. per dozen," the object of the vendors being to convey the idea that the boats with their catch were fresh from the open sea.

But, as a matter of fact, the boats were more or less permanently moored, and the catch was brought daily by rail from Brightlingsea Creek.

The oysters on their arrival at the Ipswich docks were, Dr. Elliston states, "placed in tubes filled with water either drawn from the river near a former sewer outfall or from the dock itself alongside the boats. The men in charge assured me they never took water from the dock, but from what I have seen and heard this statement appeared extremely doubtful."

Several cases of enteric fever were attributed by Dr. Elliston to the consumption of the oysters here in question.

Dr. Elliston adds, in the same annual report as that from which the above statement is taken:—

"In August, 1896, I was engaged with Drs. Thresh and Cook in investigating an outbreak of typhoid fever traced to the consumption of oysters from Brightlingsea

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In 1816 Pasquier wrote a book on "The Oyster from the Medical Point of View." Pasquier reported the case of a workman who conceived the idea of excavating a fattening bed in the moat of an old citadel into which had discharged for ages the sewage of the garrison. This workman laid down 60,000 oysters, and after some time these oysters were sold, without any regard for the disgusting conditions under which they had been prepared for market. Consumed for the first time on September 10th, 1816, nothing happened until the 20th or 21st of the same month, but about that time, that is to say after the lapse of the necessary period of incubation of enteric fever, some cases of that disease declared themselves among the consumers. It is clear, too, from the literature of this subject that attacks of diarrhœa and vomiting after the consumption of oysters were noticed in this country as early as the middle of the 19th century, and it would appear that in the visitation of this country by cholera in 1849 oysters were accredited with certain cases of this disease in Bridgwater and Taunton. In 1876 it was alleged that an outbreak of enteric fever which occurred in the Isle of Man was due to the consumption of oysters during the spawning season. It was, however, Sir Charles Cameron, C.B., M.D., who first drew the attention of the medical profession to the subject, by a paper which he read before a meeting of the British Medical Association assembled at Cambridge in 1880.

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Creek. At that time certain parts of the creek were polluted with sewage, but since that Brightlingsea has become an urban district and the pollution removed."

In view of this fact I am inclined to believe that these foreign or Portuguese oysters are free from pollution when they leave Brightlingsea, but that in transit by rail they get somewhat damaged by laying about in bags on platforms in a hot July sun. On arrival at the boats they are laid in the tubs, which are not too clean, and fed on the more or less sewage-polluted water drawn from the river or docks."

7. In 1901 and 1902 Dr. Philip Nunn, Medical Officer of Health of Bournemouth, reported on several cases of enteric fever which he attributed to the consumption of oysters procured from storage ponds in Poole Harbour.

Concerning these pits, which are within a few yards of several drain outfalls, I wrote in 1895-6:—

"The oyster pits in Poole Harbour must be regarded as amongst those which I found during the course of my inquiry to be exceptionally exposed to sewage pollution" (*see* page 64, and maps Nos. 17 and 17A of "Oyster Culture in Relation to Disease").

The condition of these ponds was in 1902 practically the same as when I made my inspection in 1895-6.

8. The "Lancet" of December 6th, 1902, contains an interesting account by Dr. Thresh and Dr. F. L. Wood of oyster-borne enteric fever and other illness which occurred in the County of Essex. Oysters were procured from St. Osyth's Creek in a position where the channel "is of considerable width, and apparently the only sewage which directly enters the channel is from a few houses at St. Osyth, one and a half miles away." The oysters were dredged up and placed in baskets, when they were taken by boat to various places on the coast, where they were sold to consumers or small dealers. The whole of the implicated oysters were sold on August 14th and 21st, on which days the boat was at Mistley, and the oysters sold at this place appear to have been responsible for four cases of enteric fever and 21 of illness. Strangely enough, as Dr. Thresh remarks, although oysters from the same original source were sold elsewhere, no illness other than one case of diarrhœa was attributed to their consumption. Dr. Thresh states: "Only one possible explanation suggests itself to me, and that is that the river water, which is greatly polluted here (*i.e.*, Mistley), may have been taken into the boats and injured the oysters lying in the bottom. This opinion is confirmed by the fact, vouched for by one of the patients, who says that he bought the last of a lot lying at the bottom of the boat, and got them cheaper because he took the lot. It would be extraordinary, however, if this peculiar condition should obtain on two successive visits. The owner of the boat is certain that no water from the river was thrown over the oysters."

9. At the end of 1902 Dr. Langdon, Medical Officer of Health of Winchester, Dr. Lauder, Medical Officer of Health of Southampton, Dr. Fraser, Medical Officer of Health of Portsmouth, and Dr. Lockhart Stephens, Medical Officer of Health of Warblington, drew attention to a most remarkable and widely spread outburst of enteric fever, which they attributed to the consumption of oysters procured from the Emsworth storage ponds. These ponds have been visited by the Royal Commission, and their obvious liability to become specifically contaminated calls for no further comment here. The Commissioners have also had my report upon this outbreak before them (*see* also page 69 and maps 20 and 20A of "Oyster Culture in Relation to Disease").

19726. Thank you. Can you now draw our attention to any outbreaks which have occurred in foreign countries other than America?—Yes; I can put before the Commission instances of outbreaks which have occurred in France, Italy, Turkey, and New Zealand.

France.

10. In June, 1896, an interesting communication by Dr. Chantemesse on "Oysters and Typhoid Fever" was brought to the notice of the Academy of Medicine in Paris, in which the author drew attention to a remarkable little outburst of enteric fever and other illness in the small town of Saint-André-de-Sangonis in Herault. The circumstances were briefly as follows:—On February 15th, 1896, an oyster merchant received from Cette a basket of oysters which were eaten raw by 14 persons in the town of Saint-André-de-Sangonis. All the 14 were taken ill, and in the six houses where the oysters were consumed those who did not eat the oysters remained well. Of the 14 persons attacked eight suffered gastro-enteritis, which lasted two or three days, four others, the youngest, who had eaten but few oysters, suffered from very severe symptoms, which lasted from 15 to 25 days, and which comprised dysenteric stools, distended and painful abdomen, general malaise, and great prostration. The remaining two persons, a girl of 20 and a young man of 21, were attacked with severe enteric fever, to which the former finally succumbed.

The incriminated oysters were taken from a canal at Cette, which passes through the town and receives an abundance of sewage and filth. (*See* pages 168 and 169 of "Oyster Culture in Relation to Disease").

Dr. Mosny, of Paris, in 1897, recorded the following outbreaks of enteric fever and gastro-enteritis which befell the members of a family residing near Paris, who consumed oysters procured direct from Cette by their servant, a native of that place. On December 31st, 1896, and January 1st, 1897, the seven members of this family partook of these oysters, and on the evening of the latter day four members of the family were attacked with gastro-enteritis, vertigo, shivering, and diarrhœa, which lasted about 24 hours. On January 17th one of these persons, a young man of 17 was attacked with enteric fever, and died on January 26th. (Revue d'hygiène, December, 1899.)

Italy.

11. Dr. H. J. Johnston-Lavis (Monte Carlo, Monaca), writing some years back in the "British Medical Journal," refers to numerous attacks of gastro-enteritis and enteric fever which occurred among persons—especially newcomers—who had recently partaken of oysters. Sometimes the gastro-enteritis occurred alone, sometimes it was followed later by enteric fever, much in the same manner as was so abundantly exemplified in the outbreaks which followed the Winchester and Southampton banquets.

Dr. Johnston-Lavis found that some of the oysters consumed, both in Naples and Rome, were dredged up from different parts of the Italian littoral, while others were brought from the Lucrine and Fusaro lakes. Under none of these conditions were the oysters, in his view, liable to specific contamination. He found, however, that the oysters when brought to Naples were stored in open meshed baskets attached to a rope, and sunk in the Santa Lucia Harbour. "Only 18 metres distant from this oyster store was the termination of one of the main drains, which there emptied its filth into this small, shallow, and stagnant pond-like port. The oysters here lived and fattened in a dark, opaque, sewage-laden water."

Apparently, however, cases of oyster-borne enteric fever and other illness continued to occur after this objectionable storage had been given up; but this Dr. Johnston-Lavis ascribes to the fact that the oyster merchants still—at the date of this communication—had their stalls in Santa Lucia, and that the oysters coming from the purer storage places were placed in tubs and buckets, "filled by water dipped up the nearest at hand, and, therefore, in great part composed of sewage."

Corsica.

12. In 1896—on April 21st—there took place an early dinner at Bonifacio, at which 16 adults sat down at one table, and 12 children (ages 8—12), with two adult nurses, at another.

Before the end of the repast one of the male guests was taken suddenly ill with colic and violent diarrhœa, and during the afternoon others were similarly affected. In the night, 14 members of the first table, together with the two adult nurses, were attacked with violent gastro-enteritis, and during the following day vomiting and diarrhœa persisted.

The first person who was attacked during the repast recovered at the end of two days. The others were ill from eight to ten days, except in the case of a young woman, who was convalescing from influenza, and who was ill for over a fortnight, and an old man, who died after being ill for nearly a month.

The oysters were the only articles of food consumed at the banquet to which suspicion could reasonably be

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* "Report to the Local Government Board upon alleged oyster-borne enteric fever and other illness following the Mayoral Banquets at Winchester and Southampton, and upon enteric fever occurring simultaneously elsewhere, and also ascribed to oysters."

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attached. All the adults, including the two nurses, had eaten 8—10 oysters, while the children who remained free from illness, had taken only two or three.

The oysters came from a private oyster park at Bonifacio on the morning of April 21st, and it transpired on inquiry that on the preceding day a sewer which empties itself near the park had been cleaned out. This cleansing was performed very rarely, and the deposits of filth had fouled the oysters. (Revue d'hygiène, December, 1899.)

Turkey.

13. In the Révue d'Hygiène et de Police Sanitaire," Vol. XXIV., 1902, page 872, Dr. Remlinger, Director of the Imperial Bacteriological Institute, records numerous instances of the alleged causation of enteric fever by the agency of oysters at Constantinople. These oysters were procured in the first instance from the waters of the Golden Horn, the Sea of Marmora, and the Bosphorous, and those waters are, Dr. Remlinger thinks, by no means free from pollution. But it appears that in actual practice the oysters are not taken direct from these places for consumption. In order that the tax imposed upon fish—oysters included—may be duly collected, all oysters must pass through the market. This market is composed of two rectangular pontoons situated on the Golden Horn, and at the bottom of a small creek of stagnant water, into which the neighbouring sewers empty their contents.

The oysters on arrival at the market are covered with sand or mud, and they are "washed" in the water of the polluted creek. During the day, too, the oysters are, from time to time, sprinkled over with water from the same source.

New Zealand.

14. I abstract the following passage from the last annual report of Dr. J. Malcolm Mason, Chief Health Officer of New Zealand.

"Enteric Fever and Oysters.

"Early this year the various district health officers were requested to examine the oyster beds, especially with regard to their possible contamination with sewage, the methods employed in storing oysters, and the condition of the wholesale and retail shops where they were sold. That this examination was taken none too soon is clearly seen by the disclosures made in the report. There have been at least two outbreaks of enteric fever traceable to pollution of the storage beds or uncleanly handling of oysters. In Blenheim there were several cases of this disease, which were traced to this source. Hitherto it has been the common practice for the oyster sellers to store the oysters along the foreshore, not only that the oysters might be handy, but in order that they might be fattened. It was found in several instances that the dealers were in the habit of placing them in baskets made of flax at the mouths of the sewers. This, I need hardly say, has been put a stop to. There was, in all, ten cases of enteric fever in Picton and Blenheim, in which oysters were the only thing common to the patients, and, as a matter of fact, no other cases occurred after the above filthy procedure was abolished. Although the outbreak in Nelson could not be traced to oysters, yet Dr. Roberts very wisely had the storage beds shifted out to the Boulder Bank, where there is no possibility of their coming in contact with sewage. In Auckland the oysters undoubtedly, in the great majority of cases, were wholesome at the time of collection, and were contaminated during their sojourn in the shops, as will be seen by Dr. Makgill's report on the Auckland District."

MUSSELS.

19727. May we now have some illustrations as regards mussels?—Certainly. I have compiled a few illustrations in the following notes, and I should also like to add that, according to the evidence which will be found at the end of the volume on "Oyster Culture in Relation to Disease," when I made in 1896 a few preliminary observations as to mussels that, in the majority of instances, where "mussel poisoning," as apart from enteric fever, has taken place, the mussels in question have apparently had opportunity of becoming fouled by sewage or other filth. I do not wish to lay undue stress upon this point, but I think it may be worth the consideration of the Commission. In the preliminary observations above referred to I also furnished the following three illustrations of mussel borne enteric fever, and I have now added other instances. It will, I think, be seen from these cases that the suspected mussels have been derived from localities obviously liable to pollution.

15. In 1883 Dr. M. K. Robinson, Medical Officer of Health to the East Kent Combined Sanitary District, recorded in his annual report to the Broadstairs and St. Peter's Urban Sanitary Authority two cases of enteric fever which were apparently contracted from the consumption of uncooked mussels procured from near the outfall of the Ramsgate sewer. Some of the mussels in question were eaten by the sister of one of the sufferers, and she was shortly afterwards attacked with vomiting and diarrhœa, but failed to develop enteric fever.

16. Dr. F. Cecil Piggott, Medical Officer of Health of Teignmouth, recorded in 1894 certain cases of enteric fever as to which the evidence pointed to mussels or cockles obtained in proximity to the outfall drain of the Infectious Diseases Hospital as having been the means by which the disease was contracted. Dr. Piggott adds that, under the circumstances which obtained at the Fever Hospital during the time to which his observations relate, it was impossible to rest assured that the excreta from certain fever patients was efficiently disinfected. From a personal inspection of this locality I am able to agree that mussels procured thereabouts must be in danger of becoming fouled by specifically infected excreta.

17. From 1894 onwards Dr. Arthur Newsholme, of Brighton, has recorded in his annual reports cases of enteric fever which he regards, and upon very strong evidence, as having probably been caused by the consumption of mussels. These mussels have in the main been collected from beds in the New Shoreham Harbour, and within a few yards of the Shoreham main outfall sewer, the sewage from which is not treated in a fashion which is in any sense likely to arrest or destroy the organisms of disease. These mussel beds have been familiar to me for many years past, and I have on repeated occasions seen men collecting these mussels from quite near to the outfall. The conditions are such as to constitute a very grave danger to the consumers of such mussels.

18. In 1895 uncooked mussels procured from certain mussel beds in the River Blyth, in Northumberland, situated near to the sewer outfall of an infectious diseases hospital, came under suspicion as having been instrumental—in the opinion of the medical officer of health of the district in which the cases occurred—in conveying enteric fever. Here again my own local inspection and inquiry showed that mussels were at times procured in dangerous proximity to the hospital sewer.

19. In his annual report for 1896 Dr. Jasper Anderson, the Medical Officer of Health of Blackpool, drew attention to a small outbreak of enteric fever which he attributed to the consumption of raw mussels taken from the jetty of the Central Pier, which is but a short distance from one of the sewer outfalls, and he subsequently reported on other cases of enteric fever derived, possibly, from the same source. Dr. F. J. H. Coutts, the present Medical Officer of Health of Blackpool, records in his current annual report the case of " a policeman who, nine days before the onset of the disease, got some mussels from a man who had been seen to pick them from the sewer outfall pipe. He and a fellow-constable ate these mussels. His comrade had severe vomiting and purging, which possibly saved him from typhoid fever, but the patient No. 53 had a severe attack, his blood giving a very typical Widal reaction."

20. Dr. Blamey, M.O.H., of Penrhyn, Cornwall, has since 1898 drawn attention in his annual reports to cases of enteric fever which in his view were probably to be accounted for by the consumption of mussels and cockles collected off the quay, and but a very short distance from the Penrhyn sewer outfall.

21. In his annual report for 1898, Dr. J. Bateley, Medical Officer of Health of Great Yarmouth, states that he has met with several instances in which enteric fever was apparently contracted from the consumption of mussels taken from the Yare. He refers also to his belief that the action of the Corporation in stopping the sale of such mussels in the town had apparently been attended with the happiest results. But in the annual report for the year 1900 Dr. C. H. Russel, the then

Dr. H. T. Bulstrode.

22 Dec. 1903.

medical officer of health, when dealing with the subject of enteric fever, reports that "some few of the cases reported earlier in the year were clearly proved to have contracted infection ffom eating mussels taken from the river in close proximity to the sewer outfalls; and it is regrettable that, notwithstanding the repeated warnings that have been given, people continue to partake of this poisonous mollusc."

As regards the preparation of mussels for market, I may perhaps add without anticipating the comprehensive report which I am preparing upon the subject, that I am aware of several places where mussels which have been procured from localities relatively remote from liability to specific pollution, but which are laid down on the foreshore within dangerous proximity of sewer and drain outfalls.

I have also visited other localities where similarly the mussels are procured at long distances from any sewer outfall, but where such mussels prior to their dispatch to market are carefully washed within a few yards and at times quite at the mouth of the sewer outfall.

I have seen illustrations of both these practices in connection with very important branches of the mussel industry.

19728. I think that if you will now give us some illustrations as regards cockle-borne enteric fever we need not trouble you further.

COCKLES.

22. In the summer of 1899 a remarkable outbreak of enteric fever took place at Exeter among children who had visited Exmouth in connection with school treats, and who had there partaken freely of raw cockles, which were regarded, after a thorough investigation, as having been the vehicles by which the enteric fever was conveyed.

Dr. G. Woodman, the Exeter medical officer of health, on inquiring as to the source of the cockles in question, found that "a sewer, the outfall of which is situated a short distance above the railway station (at Exmouth), was discharging over the mud banks from which cockles are taken, and into this sewer it was admitted that the excreta from several cases of typhoid fever was being discharged, and had been for some time previously." It seems, too, that boys were seen both gathering and washing cockles at the mouth of the sewer. Attention had also been previously drawn to this habit and to the risks which attended it by Dr. Arthur Kempe, the then medical officer of health of Exmouth.

In connection with the matter referred to above, I may perhaps add, although the whole subject has been exhaustively dealt with by the Commission in Dr. Nash's evidence, that in his annual report for 1902 Dr. John Woodman, the medical officer of health of Exeter, writes, when speaking of the decline of enteric fever in Exeter within recent years: "In looking for the cause of this very marked decline one is again brought to believe that shell-fish contamination must have played a very important part as the cause of typhoid in the city, and especially when, in reviewing past events, we find that the rise and fall of this disease in the city corresponds almost identically with the times when sewage was discharged in the vicinity of the cockle beds, and when it was removed from the vicinity of the cockle beds of which we had to complain."

23. Within recent years past, Dr. Nash, the medical officer of health of Southend, has attributed a large number of the cases of enteric fever which have occurred in that borough to the consumption of Leigh cockles, and he has placed his views in considerable detail before the Royal Commission.

Leigh cockles have also been charged with having caused numerous cases of enteric fever in the metropolis, and Dr. Allan, medical officer of the Borough of Westminster; Dr. F. W. Alexander, medical officer of the Borough of Poplar, and others have dealt with the matter in their annual reports.

The Leigh cockles are deposited in heaps on the sides of Leigh Creek, where formerly they were subject to the risks of gross pollution by crude sewage, and where now they are liable to be specifically fouled by the effluent from the recently-erected sewage works (*see* page 96 of "Oyster Culture in Relation to Disease"). Attempts have, I believe, been recently made by Dr. Collingridge and others to ensure that the "boiling" process to which they are subjected is adequate to destroy the enteric fever bacillus in the body of the cockle, but I am unable to state how far this excellent proposal has been capable of application in general practice. Hitherto it has been contended, both in regard to mussels and cockles, that anything approaching prolonged boiling renders the molluscs somewhat tough and uneatable. The method of "boiling" cockles varies materially in different parts of England and Wales, but it is not necessary that I should deal with the details at the present moment.

24. Dr. G. S. Elliston, the medical officer of health of the Borough and Port of Ipswich, has drawn attention in his annual report of recent years to numerous cases of enteric fever in which the evidence pointed strongly to cockles as the vehicle of infection. These cockles were collected in the upper reaches of the Orwell, into which is poured the practically (in so far as the destruction of organisms is concerned) untreated sewage of Ipswich, a town with a population of over 66,000.

25. Dr. W. Douglas Watson, medical officer of health of Leigh-on-Sea, furnishes in his annual report for 1902 a list of the cases of enteric fever which had been notified in his district during that year, and commenting thereon he says: "The table of cases shows that every month in the year, except December, notifications were received which very definitely points to some source of infection constantly present, such as polluted shell-fish, and the cases occurring in other districts and traced to the consumption of Leigh cockles made the circumstances very strong. This was put before your Council, and a committee formed to consider the question. A report was submitted to them which cannot be considered as settling the question of the cockle industry in Leigh. So far as I am aware, no shell-fish laid in Leigh Creek have been sold since December, 1902." Dr. Watson's report was received by the Local Government Board at the end of April, 1903.

APPENDIX.

REPORTS HANDED IN BY LEE CONSERVANCY REPRESENTATIVES.

Lower Lee Valley Main Drainage and Sewage Disposal Schemes.

LEE CONSERVANCY.

Report and Estimates on the proposed Lower Lee Valley Main Sewerage and Sewage Disposal, by Mr. C. N. Tween, Engineer to the Lee Conservancy Board, and Messrs. Pollard and Tingle, M.M.Inst. C.E., together with a report on the same, by Sir Alexander R. Binnie, M.Inst. C.E., Consulting Engineer.

Report from Sir Alexander R. Binnie.

9, Great George Street, Westminster, S.W.
May 13th, 1902.

To the Chairman and Members of the
Lee Conservancy Board.

Gentlemen,

Lee Valley Sewer Scheme.

In accordance with the arrangements made and instructions received in Mr. Corble's letters of the 7th and 8th April, and in previous correspondence, I have now the honour to report on this scheme of main drainage proposed by Messrs. Pollard and Tingle in conjunction with your engineer, Mr. Tween, for the purpose of protecting from contamination the flow of the River Lee.

It is unnecessary for me to make any remarks on the necessity of some works being constructed to remove from the River Lee as far as possible the sewage and sewage effluents which now find their way directly or indirectly into the river.

The question has long engaged the attention of almost all the important bodies concerned, and I think that, without exception, everyone is anxious that some steps should be taken to remove the nuisance, and since the sewage of West Ham has been diverted into the system of the London County Council, it has become incumbent on those bodies higher up the river, who at present send their sewage into the Lee, to formulate some scheme which would effect the object in view.

To do this effectually, the various local authorities in the Lee Valley must combine and work together as a united whole, and had this been done at an earlier date there is little doubt that some arrangement would have been made ere this to attain the desired end.

The scheme now proposed embraces an intercepting sewer, which, commencing near Waltham Holy Cross, would receive the sewage of the various districts in the Lee Valley, and carry it either into the main drainage system of the London County Council at a point a little east of the Abbey Mills pumping station, or, as an alternative, to an entirely new outfall to be constructed east of the River Roding and south of Ilford.

It is unnecessary for me to recapitulate the description of the works so ably laid before you by the gentlemen above mentioned.

I have gone over the ground with them, and have examined in detail the plans, sections, and estimates which they have prepared, and which meet with my entire approval. Of course, as negotiations proceed, minor modifications may become necessary to meet individual views, or the requirements of some or other of the various local authorities whom it is sought to serve, but, taken as a whole, it is a most excellent scheme, and one I think fraught with the fewest objections with which I am acquainted.

The general scheme from Waltham Holy Cross to the proposed pumping station at Leyton will be common to either of the two suggestions A or B, which deal more particularly with the ultimate disposal of the sewage either by A into the main drainage system of the London County Council, or B by means of a separate outfall east of the Roding.

The advantages of Scheme A are that, at a less capital cost, it once for all passes the sewage into the London system at the nearest possible point, and would relieve the Lee Main Drainage Board of all future responsibility with regard to its treatment and purification.

Against this, we have to balance certain disadvantages, among the first of which is the possible, if not certain, opposition which the scheme would receive from the county borough of West Ham, due to the passage through its district of the rising main between Leyton and Abbey Mills.

As you are aware, negotiations of a more or less tentative character have from time to time been entered into with the Main Drainage Committee of the London County Council. Hitherto, that body has refused to entertain the subject without it was supported by the combined and unanimous request of all the different local authorities concerned, and, even then, only on the condition that no rainfall was included in the sewage discharge. As pointed out in the report which I am reviewing, this restriction would necessitate the retention of the existing sewage works and sewage farms of the local authorities who now deal with the subject to cope with the small overflows due to slight falls of rain.

But the main difficulty which I apprehend in dealing with the London County Council would arise on the subject of payment. I notice that Messrs. Pollard and Tingle, in their report, quote the Tottenham and Wood Green Act of 1891 and the West Ham Corporation Act of 1893, and, although those gentlemen have worked on that basis, I cannot conceal from you my opinion that I do not believe that the London County Council will ever again willingly concede such favourable terms. That body is fully alive to the difference of rateable value in its own area and in the districts beyond its boundary, and, I feel sure, will not again willingly consent to outside authorities participating in the advantages of its main drainage system on the same economical terms of rating at which it is able to deal with the question within its own county area. Besides which it must be remembered that the London County Council have already commenced the construction of large works to deal with the increased population within its own area, which ultimately will involve an additional capital expenditure of about £2,000,000 sterling. Taking, therefore, these two considerations into account, I feel that it would be imprudent to assume that the main drainage rate which would have to be paid to the London County Council will remain at its present low figure.

Looking now to Scheme B, which proposes to establish a new outfall eastwards of the River Roding, we have the disadvantage that the first capital expenditure would be larger than in Scheme A ; against this we may balance the avoidance of the opposition of West Ham and obtain the advantage of being able to deal with all the smaller falls of rain from the roofs and backyards, and, at the same time, secure ourselves against the unknown, but certain increase in the annual charges which no doubt from time to time would have to be paid to the London County Council.

Besides its other advantages, Scheme B is capable in the future of modifications and extensions, which would not be possible if Scheme A were adopted, and, under any circumstances, should an increased quantity of sewage be discharged in the future into the London County Council system, it would, no doubt, involve further negotiations, and possibly increased contributions being demanded.

I have very carefully considered the mode in which it is proposed to deal with the crude sewage on its arrival at the outfall works near Ilford, and can but say that it is almost exactly that which, on leaving the London County Council service after ten years' experience, I advised them to adopt in the future, with this important addition, that the effluent, after sedimentation, would undergo a process of bacterial filtration. This system, as proposed by Mr. C. N. Tween and Messrs. Pollard and Tingle, I am sure, should not be the cause of any nuisance to the neighbourhood, situated, as it is, far removed from residential property, and it has the advantage of being capable of extension should necessity require, as it is surrounded by agricultural land only.

I have gone in detail through the estimates which have been prepared, and, with my knowledge of current prices, consider them to be ample.

As regards the very careful statistics of population and rateable value of the various districts concerned, I, of course, depend on the accuracy of the figures placed before me in the report under review, but, as far as I am able to judge, they appear to me to represent what, from my general experience, I should anticipate to be the facts of the case.

Reviewing, therefore, the whole subject, I consider that the scheme laid before you is very good, but that the preponderating advantages of an independent outfall, as suggested in Scheme B, far outweigh anything that can be said in favour of Scheme A.

Hoping that this review of the subject will at the present moment be considered sufficient,—I have the honour to be, gentlemen, your obedient servant,

ALEXR. R. BINNIE, M.Inst.C.E.

REPORT from Mr. C. N. TWEEN and Messrs. POLLARD and TINGLE.

Lee Conservancy, 12, Finsbury Circus,
London, E.C., 1st May, 1902.

To the Chairman and Members of the
Lee Conservancy Board.

Gentlemen,

Lower Lee Valley Main Sewerage and Sewage Disposal.

On the 18th October last the Board passed a resolution declaring that, looking to the polluted condition of the lower portion of the River Lee, and to the necessity for taking the sewage of the towns and districts affected right out of the valley, and also to the largely increasing population of certain areas, the board, in conformity with the powers given by Section 89 of the Lee Conservancy Act, 1868, do assist the local authorities in carrying forward the Lower Lee Valley Main Sewer Scheme by at once preparing the necessary surveys, plans, and estimates, and instructing us to carry out this order.

In pursuance of these instructions we have made the surveys and obtained the information to enable us to give effect to the order of the board, and now have the honour to submit plans and sections of the scheme, together with the following report and estimate.

Deputation to the London County Council Main Drainage Committee.

In July of last year a deputation of the authorities interested was received by the Main Drainage Committee of the London County Council, at which meeting we were present. After Mr. Barnard had explained the views of the authorities, Mr. Ward, the vice-chairman of the committee, who was in the chair, stated that certain conditions were essential if the sewage was to be dealt with by the Council.

These conditions were:—

Conditions suggested as essential if Council took in Sewage.

1. Sewage to be delivered by the authorities into the Northern Outfall Sewer at a point which would not involve further pumping by the Council.

2. Quantity delivered to the Council to be strictly limited to the dry weather flow, which was stated to be 25 gallons per head per day.

3. A lump sum to be paid down to the Council equivalent to that part of the capital amount which the Council has already repaid in capital expenditure.

4. That the authorities pay the main drainage rate of London.

The committee intimated that, whilst inclined to regard the proposal with sympathy, they must further consider it before they could send a reply, especially as it appeared the authorities were not unanimous, but it might be taken that if the Council consented, the terms would be somewhat analogous to those proposed to West Ham.

Positio intake Counci Sewer.

At a subsequent interview we had with Sir A. Binnie, then Engineer to the Council, he expressed the opinion that the intake should be below Abbey Mills Pumping Station, between which point and Barking the Council are now enlarging the northern outfall sewer.

Two sc prepare submit

In view of the fact that the Council held out no hopes of taking any of the rainfall into their sewer, we came to the conclusion that to present a scheme which left a portion of the wet weather flow to be treated at the existing works and the resulting effluent to be discharged into the present channels would not fully comply with our instructions. We have therefore considered two schemes, the first delivering the sewage into the Council's sewer, and the second, with an independent outfall, where the sewage will be treated and the effluent delivered into the Thames to the east of Barking Creek, and we now beg to submit the two proposals for your consideration.

The first is referred to in this report as Scheme A and the second as Scheme B, the intercepting sewer between Waltham Abbey and Leyton being common to and identical in each.

SCHEME A.—Intercepting Sewer, Waltham Abbey to Leyton. Sewage delivered into Northern Outfall Sewer of the London County Council.

Route Interc Sewer

The route of the sewer, together with the depths and sizes at the various points of intake, are clearly shown on the accompanying plans and sections, hence but a very brief description is required.

The sewer commences at Waltham Abbey Sewage Works, passes thence through a portion of the Royal Gunpowder Factory, under the Navigation River to the Cheshunt Sewage Works, thence along the eastern side of the Great Eastern Railway to the Enfield Sewage Works, thence by the side of the East London Water Company's catchwater drain to Angel Road, passing the Edmonton Sewage Works, leaving Angel Road the sewer crosses the Navigation River and runs between the reservoirs now being constructed by the water company, thence skirts the eastern boundary of the water company's property to the Tottenham and Forest Gate Railway, crossing under the same through an existing arch, thence to the Walthamstow Sewage Works and the Leyton Sewage Works. The sewage from the Royal Small Arms Factory and from Chingford is brought down to the main sewer by branch sewers.

Depth size of Interc sewer

The sewer will be laid at a depth sufficient to allow the lowest sewers of the various authorities to deliver into it at the springing level by gravitation, and commencing with an 18in. pipe from Waltham; the diameter of the sewer is increased at each intake until it becomes 7ft. 6in. between Walthamstow and Leyton. In each case the enlargement is made downwards, so that the full discharging capacity is given at the point of enlargement.

Manh and s entra

Manholes, where the sewer is of small diameter, and side entrances and ventilators where it is of large diameter, are provided in order that access may be given to the sewer.

Storm overfl

Storm overflows will be fixed where possible, but none will discharge into the River Lee above the intake of the East London Water Company at Keids Weir. The overflows above this point will discharge into the intercepting drain of that company, which at present receives the effluents from Cheshunt, Enfield, and Edmonton.

A subsoil drain is provided for in the estimate to enable the water to be kept down during the construction of the sewer.

Site Pum Stati

In proximity to the Leyton Sewage Works it is proposed to acquire six acres of land upon which to erect a pumping station. This land is alongside the Temple

Mills sidings of the Great Eastern Railway, so that it will be an inexpensive matter to construct a siding from the railway into this site for the delivery of coal and stores.

Hoist.

At the end of the sewer a filth hoist will be constructed for the purpose of straining the sewage.

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The intercepting sewer will deliver into a reservoir which will also receive the sewage from Leyton. The bottom of the reservoir will be 20ft. below the invert of the sewer. This reservoir to the invert level of the sewer will contain about 1,500,000 gallons, and is intended to equalise to a certain extent the maximum and minimum flow, so that the work of the pumps may be fairly uniform.

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ed for.

The ultimate population provided for is three times the present population, except in the case of Leyton, where it is taken as twice, as the area at present unbuilt on will only admit of such increase, and the Royal Small Arms Factory, where it is estimated at 5,000 persons.

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The quantity of sewage has been calculated at 25 gallons per day per head of ultimate population, and the sewer designed on the assumption that one-half of this daily flow comes down in six hours, that is to say, when running half full the discharging capacity of the sewer is equal to the maximum flow from a population nearly three times greater than the present.

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Nos.
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Tables Nos. 1, 2, and 3 give detailed particulars as to population, rate of increase, inhabited houses, acreage, etc., diameter, inclination, level of invert and discharging capacity of sewer when running half full at each of the intakes of the sewers from the local authorities.

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At the pumping station, boiler and engine houses, etc., will be constructed.

The pumping plant we propose will consist of:—

Four triple expansion condensing engines.

Four single-acting ram pumps.

Four Yancashire boilers for steam at high pressure;

together with mechanical stokers, fuel economiser, and all necessary feed, steam, suction, and delivery pipes and overhead crane.

Each engine and pump will force through the rising main 5,580,000 gallons in 24 hours, and three engines and pumps will be equal to dealing with the maximum flow from half the ultimate population with the aid of the equalising reservoir; the fourth engine and pump being provided as a standby in case of accident. It is proposed to pump continuously throughout the 24 hours, but the night flow will only require one pump.

Main.

The rising main, consisting of a cast-iron pipe 36in. in diameter, will discharge the quantity delivered by the pumps from the reservoir. The route proposed is shown on the plans, being from the pumping station across the Great Eastern Railway (Loughton Branch) into the Borough of West Ham, along Leyton Road, Angel Lane, West Ham Lane, Abbey Road, Manor Road, to the northern outfall sewer at the south of Corporation Street.

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Provision will be made here by a suitable arrangement of penstocks to deliver the sewage into either of the five sewers forming the northern outfall.

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The London County Council stipulate that no rainfall shall be admitted into the sewer; therefore it will be necessary to make provision at the intakes to limit the quantity taken in to, say, 25 gallons per day per head of population. The effect of this limitation will be that each of the authorities must retain pumping plant and some land at their existing outfall works, together with the necessary labour to deal with the excess over the limit in wet weather. In the case of Cheshunt, where the daily flow is always greater than the admissible quantity, expense under this head would be incurred daily.

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No. 4.

Table No. 4 gives particulars of rateable values and amount produced by 1d. rate.

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In Appendix A is given an estimate of cost, together with a statement showing the annual sum and rate required to pay off principal and interest for loan borrowed for 30 and 60 years. Should this scheme be proceeded with, it would be necessary to obtain an Act of Parliament. and it is probable sanction would be obtained for the repayment of the loan being spread over a period of 60 years, except in the case of the sum required for machinery.

The estimate of cost amounts to £324,473, including land, easements, engineering, and cost of obtaining an Act of Parliament. If this sum is borrowed for 60 years at 3¼ per cent., the annual amount to be raised to pay off interest and principal in equal instalments will be £12,727.

Capital payment to London County Council.

In addition to the above, there is the capital sum to be paid to the London County Council. In the Tottenham and Wood Green Act of 1891 this payment is provided for in Section 10, and amounts to £72,820, spread over a period of 58 years. In the case of West Ham, the West Ham Corporation Act, 1893, provides (Section 18, Sub-section 9) for this payment to be made on such principle and in such manner as may be agreed between the Council and the Corporation, and failing agreement to be determined by an arbitrator.

We understand the Council in June, 1901, asked West Ham £113,000 to be paid in a lump sum, and arrived at this amount by a comparison of the assessable value to county rate of West Ham to that of London.

The assessable value of West Ham to county rate in 1900, when the sewage was admitted to the nothern outfall sewer, was £1,146,407. The assessable value to county rate of the districts to be served by this scheme is about £1,372,140, and assuming the Council follows the West Ham precedent, the capital sum the authorities will be asked to pay will amount to about £135,250.

If this sum is borrowed for sixty years at 3¼ per cent., the annual sum to pay off principal and interest will amount to £5,153.

Adding to this annual payment that arrived at previously for works makes a total annual payment of £17,880.

The authorities will probably borrow the loan on the security of the district rate.

Rate required to pay for work and capital to London County Council.

A penny rate to district rate (Lady Day, 1902, see Table No. 4) amounts to £4,576, therefore, to raise the annual amount of £17,880 for repaying the principal with interest would necessitate a 4d. rate.

Main Drainage Rate of London.

To this must be added 3¼d., the amount of the main drainage rate of London. This rate will probably be charged by the London County Council upon the county rate valuation, viz., £1,372,140, and the amount to be raised annually will be £18,581. This sum will have to be collected by the districts on the district rate valuation, and to raise it will necessitate an annual rate of 4d. This amount should be reduced in 1929 if the Council do not expend more money on capital account.

Working expenses.

Working expenses we estimate at £7,500, necessitating nearly a 1¾d. rate.

Total Rate.

The total rate, therefore, amounts annually to 9¾d. for period of sixty years, or for period of thirty years to 11d. In addition there will be the expense to each authority at their present outfall works of dealing and disposing of the excess over twenty-five gallons per head per day in wet weather.

SCHEME B.—Outfall sewer delivering to disposal works at Barking, and effluent discharged into the River Thames east of Barking Creek.

Waltham Abbey Leyton Sewer and Pumping Station.

The sewer from Waltham Abbey to Leyton, with the pumping station and reservoir, are identical with those in Scheme A.

Rising Main.

From the pumping station it is proposed to lay a cast-iron rising main, 42ins. in diameter, along part of Quartermile Lane, Ruckholt Road, York Road, Alexandra Road and Grove Green Road, into Claremont Road at its northern end, thence crossing the Loughton branch of the Great Eastern Railway, and terminating in a small chamber to be placed in the New Road at the north of the Leyton Generating Station, close to Cathall Bridge.

Route of Sewer Leyton to Barking.

At this chamber it is proposed to commence a gravitating sewer, 96ins. in diameter, and to lay the same along Cathall Road, Harrow Road, across Wanstead Flats to the north of the City of London Cemetery, along its eastern boundary nearly to the railway skirting the northern side of the railway, and crossing Alders Brook and the River Roding, to and along Priory Road, Ley Road, crossing the main line of the Great Eastern Railway, into and along Willow Walk, Oakfield Road, Albert Road, and Woodlands Road, thence through private land, crossing Loxford Water and Water Lane close to the Ilford Sewage Works, and Longbridge Road to the east of Fair Cross, to its termination at the preposed outfall works on Porter's Lodge Farm to the east of Upney Lane.

Discharging capacity of Rising Main.

The rising main will carry the quantity delivered by the four pumps equal to 22,320,000 gallons in twenty-four hours, which, with the aid of the equalising reservoir, is sufficient to deal with the daily flow of half the ultimate population and a proportion of rainfall.

Discharging capacity of Sewer.

The 96in. brick barrel sewer will be given an inclination of 1 in 2,640, and will, when running half full, discharge 35,280,000 gallons in 24 hours, being 13,067,225 gallons in excess of the daily flow from the ultimate population. This excess of discharging capacity is provided to cope with the maximum flow from the portions of Walthamstow and Leyton, which can be intercepted and conveyed to the outfall by gravitation, as explained later in this report.

Special construction.

The configuration of the ground necessitates some special construction at several points. These are clearly shown on the sections. In two places there will be an arched aqueduct carrying the sewer, each aqueduct being about 70 yards in length.

The Roding Valley is crossed by an inverted syphon, consisting of two cast-iron pipes each 42ins. diameter. The syphon is about 2,000ft. in length, and sufficient head is given to enable each pipe to discharge a little more than one-half free flow from the ultimate population at a velocity which should prevent any deposit being formed, but provision will be made to connect each tube to the low level sewer of the Ilford Council, so that, when necessary, one tube may be emptied at a time, and a man sent down to examine, clean, or repair.

One of the Ilford Council's sewers will have to be taken under the proposed sewer, and Water Lane, where it crosses, will have to be raised 8ft. in order to carry it over the proposed sewer.

Lower length Sewer partially out of ground.

For the length of about 1,270 yards at its lower end the sewer will be partially out of ground. Here it will probably be necessary to buy a strip of land and to bank the sewer over with earth, soiling and seeding the same.

Side entrances and storm overflows.

Side entrances and storm overflows are provided where shown on the section.

Existing Sewer from Leytonstone intercepted.

At the crossing of High Road at Harrow Green the existing sewer coming from Leytonstone will be connected, and the sewage brought down by it to this point intercepted and conveyed by gravitation to the Barking site.

Possibility of intercepting sewage from other parts of Leyton and Walthamstow.

It will also be possible to intercept the sewage from portions of Walthamstow and Leyton, by constructing a sewer delivering by gravitation into the chamber at the head of the 96in. sewer. It is not proposed to construct such a sewer at present, and the cost is not included in the estimate; but we have prepared plan and section, although they are not submitted with this report. From the chamber this sewer would be taken along Grove Green Road to the Tottenham and Forest Gate Railway, thence keeping close to the northern boundary of the railway to Walthamstow Station, thence along Erskine Road, Melville Road and Forest Road, to the junction with Hoe Street North, thence through private land to the existing sewer at the end of Victoria Road which comes from the Highams.

When constructed this sewer will intercept the sewage from the existing sewers where crossed, and convey it by gravitation to the 96in. sewer, the discharging capacity of which is sufficient to deal with the maximum flow from the intercepted area in addition to the quantity pumped.

Areas that can be intercepted.

The areas that can be intercepted by this means are those portions of Leyton and Walthamstow lying to the east and north-east of the line of route.

Cost of Pumping to be reduced.

By this means the annual cost of pumping will be much decreased, but at present we do not think the population is sufficient in the proposed intercepted area to warrant the expense of constructing the sewer.

Rainfall.

The districts under the control of the authorities interested are drained, we understand, upon the separate system, the rainfall from the back roofs of the houses and paved yards at the rear only being admitted to the sewers.

The average number of persons per house of the present population is 5·7. Therefore, on the same ratio, when the population reaches 444,255, being half the ultimate, the number of inhabited houses will be 77,062. Taking the area of the back roofs and paved yards at 1,000 sq. ft. per house, the area for half the ultimate population delivering the rainfall to the sewer and to the reservoir will be 1,800 acres.

Before the storm overflows come into action the sewer will be full for a considerable distance. The storage capacity of sewer and reservoir up to the level of the lip of the lowest storm overflow is 7,594,663 gallons. With four pumps running and the sewer receiving the sewage from 444,255 persons, and the rain from 77,062 houses, or 1,800 acres, falling continuously at the rate of ½ in. in 24 hours, it will be 20 hours before the overflows come into action. With ¼ in. of rain falling in one hour on the 1,800 acres of roofs and yards, it will be 50 minutes before the overflows discharge.

For the ultimate population of 888,511 the number of houses will be 155,000, and the total area of roofs and yards 3,560 acres.

With the sewage from this population and the rain from this area falling continously at the rate of ½ in. in 24 hours, the storm overflow will not come into action until after 10 hours, providing the rising main and pumping machinery are duplicated.

The 96-in. sewer from Leyton to Barking will scarcely be affected by the rainfall, as the bulk of the quantity delivered to it has to be pumped, and the flow is thus restricted.

Outfall Works.

It is proposed to acquire an area of 120 acres, as shown on the plan, for the purpose of carrying out the work of purifying the sewage.

The soil is generally light loam on the surface, with a gravel subsoil.

It is proposed to construct open subsidence tanks of sufficient capacity to contain the daily dry weather flow from a population equal to one-half of the ultimate population. The sludge obtained from the subsidence in these tanks will be withdrawn as it becomes necessary and disposed of upon the lower part of the land. The sewage will pass over a weir from these tanks on to twelve artificial filters or contact beds. These beds will be constructed of concrete and filled with the material excavated during their construction after it has been screened.

The beds will be filled and emptied in succession automatically twice in the 24 hours, sufficient time being given for aëration between the fillings.

The effluent water, upon leaving the contact beds, will be delivered through a cast-iron pipe into the River Thames below low water.

The level of the outlet from the filters is 16 ft. above Ordnance Datum. They will therefore discharge at any state of the tide.

From our experience elsewhere, it is anticipated that this treatment will remove the whole of the suspended matter in the sewage, and that a purification of about 80 per cent. will be obtained uniformly. This we consider sufficent, as the effluent enters a large body of tidal water. The area of land proposed to be acquired will permit of the extension of the tanks and contact beds as it may become necessary from the increase of population. There is also a large area of land in the immediate neighbourhood that could be acquired and made available for the disposal of additional sewage if required at any future time.

Esti

An estimate of cost is given in Appendix B amounting to £643,433—for works, machinery, land, easements, engineering and cost of Act.

If the sum is borrowed at 3¼ per cent. for 60 years (machinery for 30 years) and paid off in equal annual instalments of principal and interest, the amount required per annum will be £24,952—equal to a 5½d. rate on the present rateable value. The working expenses are estimated at £12,000 per annum, necessitating a 2½d. rate.

Rate

The total rate required will therefore be 8d. for period of 60 years, or for period of 30 years, 10d.

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It must be borne in mind that if this scheme be adopted each authority will be relieved of all expense at their existing outfall works, and the land now used for farms can be disposed of.

Table No. 1 gives the annual cost of working the present outfall works, and Table No. 4 the amount produced in the present year by 1d. rate to each authority, from which it appears the disposal of the sewage is now costing each authority per annum the rates as follows:—

Rate required by each authority for working expenses at the existing outfall works.

Waltham Abbey	1·31*d.* rate per annum.
Cheshunt	4·27*d.* „ „
Enfield	1·07*d.* „ „
Southgate	3·41*d.* „ „
Edmonton	2·50*d.* „ „
Chingford	1·52*d.* „ „
Walthamstow	4·66*d.* „ „
Leyton	3·60*d.* „ „

The Royal Small Arms Factory will save £124 per annum.

Table No. 1 gives the area of each sewage farm. Assuming these are sold and the money received put out to interest at 3¼ per cent. per annum, the dividends being applied in reduction of the rates, the amounts thus received by each authority will equal:—

Rate saved by Sale of Existing Farms.

Waltham Abbey	Farm sold at £200 per acre	0·75*d.* rate per annum.
Cheshunt	„ „ 250 „	1·14*d.* „ „
Enfield	„ „ 300 „	1·62*d.* „ „
Edmonton	„ „ 300 „	3·87*d.* „ „
Chingford	„ „ 300 „	1·28*d.* „ „
Walthamstow	„ „ 500 „	2·25*d.* „ „
Leyton	„ „ 500 „	0·13*d.* „ „

The Royal Small Arms Factory will gain 20¾ acres.

Adding the amounts of each authority together will give the amount of rate saved, and deducting this from the total rate required will give the extra rate to each authority on the present rateable value as shown below.

Rate required to be levied by each Authority after deducting amounts saved by abolition of present working expenses and sale of existing Farms.

——	Annual Rate saved by sale of existing Farms and extinction of rate required to pay present working expenses.	If Loan borrowed for 30 Years.		If Loan borrowed for 60 Years.	
		Annual Rate required to execute work. 10*d.*	Annual Rate required in each District on ratable value for year 1902, in addition to present rates.	Annual Rate required to execute work. 8*d.*	Annual Rate required in each District on assessable value for year 1902, in addition to present rates.
			d.		*d.*
Waltham Abbey	2·06	—	8	—	6
Cheshunt	5·41	—	4½	—	2½
Enfield	2·69	—	7¼	—	5¼
Southgate	3·41	—	6½	—	4½
Edmonton	6·37	—	3¾	—	1¾
Chingford	2·80	—	7¼	—	5¼
Walthamstow	6·91	—	3	—	1
Leyton	3·73	—	6¼	—	4¼

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If thought advisable there is no reason why the Urban Districts of Wanstead, East Ham, Ilford and Barking should not come into the scheme, but as they are outside the Lee Valley we have not included them.

parison
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d B.

Briefly comparing the two schemes, A possesses the advantage of the authorities being relieved of the disposal and treatment of the sewage. The objections to A are that each authority must incur expense at their present works to deal with the excess over the quantity admitted to the London County Council Sewer, that the whole of the farms cannot be disposed of, and that the price obtained for the portions sold will not be so high as in B, owing to the retention of the existing sewage works, and that the whole of the sewage is not taken out of the Valley. Even when allowance is made for reduction of present working expenses, etc., and sale of part of the farms, we think A will cost in the end more than B.

B imposes on the authorities the duty of treatment and disposal of the sewage at the outfall, takes all the sewage and rainfall (except the excessive falls) out of the Valley, and enables all existing works to be abolished and farms sold.

Should Scheme B be carried out, we are convinced there will be no pollution of the Lee south of Waltham Abbey, and the backwater running through Leyton and West Ham will benefit by the removal of the sewage effluents at present discharging therein.

In conclusion we wish to express our thanks to the engineers of the East London Water Company and of the Great Eastern Railway, also to the engineers of the various authorities for the information and assistance they have given us. We regret the action of the Edmonton Urban Council in declining to furnish information, and have, failing official statistics, obtained our information relating thereto from the best sources open to us.

We shall be pleased to give further information if required.

Your obedient Servants,

C. N. Tween, Engineer Lee Conservancy Board.

Pollard and Tingle, M.M.Inst.C.E.,
31, Old Queen Street, Westminster, S.W.

TABLE No. 1.

YEAR 1901.

PARTICULARS of present Population and Dry Weather Flow of Sewage, &c.

——	Population, 1901.	Rate per cent. of Increase last decade.	Inhabited Houses.	Area of District.	Dry weather flow, 24 hours from present population.	Gallons per head of population.	Area of existing Sewage Farm.	Annual cost of Outfall Works.
				Acres.	Gallons.	Gallons.	Acres.	£.
Waltham Abbey - - - -	6,547	7·8	1,311	11,017	150,000	23	13¼	150
Cheshunt - - - -	12,288	27·5	2,480	8,480	*415,500	34	24½	747
Royal Small Arms Factory -	†4,000	—	—	—	40,000	10	20¾	124
Enfield - - - -	42,738	35·5	7,988	12,653	900,000	21·6	110	705
Edmonton - - - -	46,899	83·2	7,806	3,890	†1,625,000	26·3	230	†1,450
Southgate - - -	14,993	39·0	2,815	3,593			—	†1,201
Chingford - - - - -	4,372	60	826	2,791	126,000	29	13	150
Walthamstow - - - -	95,125	103·1	16,161	4,472	2,000,000	21·3	170 25	Freehold 5,600 Leased
Leyton - - - - -	98,899	56·67	17,077	2,270	2,500,000	25·3	10½	4,920
	325,861	51·6	56,464	49,168	7,756,500	23·8	617	15,047

* Flow appears to vary with height of sub-soil water. † Estimated.

TABLE No. 2.

PARTICULARS of ultimate Population provided for, and quantity of sewage derived therefrom, calculated at 25 gallons per head. Dry weather flow.

——	Ultimate Population.	Gallons per minute mean flow.	Gallons per minute maximum flow.	Gallons per 24 hours.
Waltham Abbey - - - - - - -	19,641	340	680	491,025
Cheshunt - - - - - - - - -	36,864	640	1,280	921,600
Royal Small Arms Factory - - - -	5,000	87	174	125,000
Enfield - - - - - - - - -	128,214	2,225	4,450	3,205,350
Edmonton Southgate - - - - - - - - -	185,676	3,225	6,450	4,641,900
Chingford - - - - - - - -	13,116	228	456	327,900
Walthamstow - - - - - - - -	300,000	5,206	10,412	7,500,000
Leyton - - - - - - - -	200,000	3,475	6,950	5,000,000
	888,511	15,426	30,852	22,212,675

TABLE No. 3.

Particulars of Dry Weather Flow from ultimate Population and discharging Capacity of Sewer, Invert Levels, &c.

Sewer from	Dry Weather flow from ultimate population for 24 hours, in gallons. See Table No. 2.	Discharging capacity of Sewer when running half full for 24 hours, in gallons.	Diam. of Sewer.	Inclination.	Level of Invert at Intakes.
					Feet above Ordnance Datum.
Waltham Abbey to Cheshunt -	491,025	999,000	18″	1 in 800	Waltham - 51·59
Cheshunt to Small Arms Factory	1,412,625	3,159,000	30″	1 in 1,000	Cheshunt - - 42·07
Small Arms Factory to Enfield -	1,537,625				S.A.F. Junction of Branch Sewer 36·00
Enfield to Edmonton - -	4,742,975	10,098,000	48″	1 in 1,000	Enfield - - 25·75
Edmonton to Chingford - -	9,384,875	19,593,000	72″	1 in 2,000	Edmonton - - 16·45
Chingford to Wolthamstow -	9,712,775				Chingford Junction of Branch Sewer. 11·50
Walthamstow to Leyton - -	17,212,775	34,443,000	90″	1 in 2,000	Walthamstow - 5·14
Add Leyton received in Reservoir.					
Quantity delivered to Pumping Station.	22,212,775	—	—	—	Leyton - - 1·25
Leyton to Barking Gravitating Sewer.	—	35,280,000	96″	1 in 2,640	Leyton - - 32·22 Barking - - 20·00

TABLE No. 4.

Particulars of Rateable Value. Amount produced by 1*d.* Rate.

	County Rate Valuation, Lady Day, 1902.	District Rate Valuation, Lady Day, 1902.	
	Assessable Value.	Assessable Value.	Amount produced by 1*d.* Rate.
	£.	£.	£.
Waltham Abbey - - - - - -	41,976	33,091	114
Cheshunt - - - - - - -	73,056	44,448	175
Enfield - - - - - - -	218,306	172,890	660
Edmonton - - - - - - -	175,244	164,344	580
Southgate - - - - - - -	105,221	99,096	355
Chingford - - - - - - -	23,648	23,733	99
Walthamstow - - - - - -	337,076	312,537	1,224
Leyton - - - - - - -	*397,613	397,613	1,369
Total - - -	1,372,140	1,247,752	4,576

* Taken as District Rate, Wanstead slip area being outside Leyton for Poor Rate purposes.

Note.—Nothing has been included for the Royal Small Arms Factory as rateable value, though, doubtless, the Government would make a contribution to the Capital cost of the works, and, it is assumed, pay an annual amount for working expenses.

APPENDIX A.

Estimate of Cost, and of the Annual Sum to be raised, with amount of Rate in the £ to defray the same, for Scheme A, delivering into the Northern Outfall Sewer of the London County Council.

———		ESTIMATE OF COST.	Annual Sum and Rate required to pay off Loan in equal Annual Instalments of Principal combined with Interest.			
			If Loan is borrowed for 30 years at 3¼ per cent.		If Loan is borrowed for 60 years at 3¼ per cent.	
			1.	2.	3.	4.
			Annual sum to be raised to repay Loan and Interest and defray Working Expenses.	Rate in the £ (on assessable value to District Rate as on Lady Day, 1902) to be levied annually to meet sums required as set out in Column 1.	Annual sum to be raised to repay Loan and Interest and defray Working Expenses.	Rate in the £ (on assessable value to District Rate as on Lady Day, 1902) to be levied annually to meet sums required as set out in Column 3.
	£ s. d.	£ s. d.	£ s. d.	d.	£ s. d.	d.
Main Sewer, Rising Main, Engine and Boiler Houses, including 10 per cent. for contingencies.		262,703 – –				
Engineering, 5 per cent.	14,385 – –					
Supervision during construction.	4,000 – –					
Cost of Act and Legal Expenses.	10,385 – –	28,770 – –				
Land and Easements - • -		8,000 – –				
		299,473 – –	15,776 – –	3·45	11,410 – –	2·49
Machinery - - - - - -		25,000 – –	1,317 – –	·29	* 1,317 – –	·29
		324,473 – –	17,093 – –	3·74	12,727 – –	2·78
Capital payment to the London County Council.		135,250 – –	7,125 – –	1·56	5,153 – –	1·12
		459,723 – –	24,218 – –	5·30	17,880 – –	3·90
Main Drainage Rate of London, 3¼*d.* on County Rate Valuation, 1,372,140*l.* (*see* Table No. 4).			18,581 – –	4·06	18,581 – –	4·06
Working Expenses - - - - - -			7,500 – –	1·64	7,500 – –	1·64
			50,299 – –	11·00	43,961 – –	9·60
				Total rate per annum = 11*d.*		Total rate per annum = 9¾*d.*

* NOTE.—A Loan for this purpose would only be sanctioned for 30 years.

APPENDIX B.

Estimate of Cost, and of the Annual Sum to be raised, with amount of Rate in the £ to defray the same, for Scheme B, delivering to Disposal Works, and discharging the Effluent after treatment into the River Thames to the East of Barking Creek.

——		Estimate of Cost.	Annual Sum and Rate required to pay off Loan in equal Annual Instalments of Principal combined with Interest.			
			If Loan is borrowed for 30 years at 3¼ per cent.		If Loan is borrowed for 60 years at 3¼ per cent.	
			1.	2.	3.	4.
			Annual sum to be raised to repay Loan and Interest and defray Working Expenses.	Rate in the £ (on assessable value to District Rate as on Lady Day, 1902) to be levied annually to meet sums required as set out in Column 1.	Annual sum to be raised to repay Loan and Interest and defray Working Expenses.	Rate in the £ (on assessable value to District Rate as on Lady Day, 1902) to be levied annually to meet sums required as set out in Column 3.
		£. s. d.	£. s. d.	d.	£. s. d.	d.
Main Sewer, Rising Main, and Engine and Boiler Houses, including 10 per cent. for contingencies.		424,485 – –				
Tanks, Filters and Effluent Pipe -		80,000 –				
	£. s. d.					
Engineering, 5 per cent.	26,474 – –					
Supervision	8,000 – –					
Cost of Act and Legal Expenses.	18,474 – –	52,948 – –				
Land and Easements - - -		56,000 – –				
		613,433 – –	32,316 – –	7·06	23,372 – –	5·11
Machinery - - - - -		30,000 – –	1,580 – –	·34	*1,580 – –	·34
		643,433 – –	33,896 – –	7·40	24,952 – –	5·45
Working Expenses - - - - - -			12,000 – –	2·62	12,000 – –	2·62
			45,896 – –	10·02	36,952 – –	8·07
				Total rate per annum = 10*d.*		Total rate per annum = 8*d.*

* NOTE.—A Loan for this purpose would only be sanctioned for 30 years.

INTERCEPTING SEWER (BISHOP'S STORTFORD TO HARLOW) AND SEWAGE DISPOSAL SCHEME.

Lee Conservancy, 12, Finsbury Circus,
July 8th, 1902.

To the Chairman and Members of the
Lee Conservancy Board.

Intercepting Sewer, Bishop's Stortford to Harlow, and Sewage Disposal.

Gentlemen,—In pursuance of your instructions that we should make the necessary surveys, prepare plans and estimates, together with a report upon the best means for intercepting the sewage from Bishop's Stortford, Thorley, Sawbridgeworth, and Harlow, and conveying it to one outfall for treatment by the most modern methods, we now have the honour to submit our report and estimate of cost thereon, accompanied by plans and sections.

Examination of district.

We have visited the outfall works of Bishop's Stortford, Sawbridgeworth, and Harlow, and made a careful examination of the district, in order to ascertain the best route for the intercepting sewer and the most suitable site for the outfall works.

Conditions to be fulfilled by scheme.

From the first it was clear that the sewer must be located sufficiently low to drain the houses, and yet kept high enough to enable the sewage to gravitate to the outfall works, and there command an area of suitable land for sewage disposal above flood level.

The physical characteristics of the district are such as to render it extremely difficult to design a scheme which embraces all requirements, but, having given great consideration to the matter, we conclude the proposals now made most nearly comply with the essential provisions at which we aimed.

Tables Nos. 1 and 2.

At the end of this report, Tables Nos. 1 and 2 are annexed, giving particulars of population, rateable value, working expenses at present outfalls, flow of sewage, diameter and discharge of sewers, etc., etc.

Route of intercepting sewer from Bishop's Stortford to outfall site at Harlow.

The route proposed for the intercepting sewer is clearly shown on the plans and sections accompanying this report; hence but a brief description is required. The sewer commences in Bishop's Stortford, at the existing manhole in Southmill Road, close to the boundary of Thorley Parish. Here the existing Southmill Road sewer will be intercepted, and the sewage from the existing London Road sewer will be brought to the intercepting sewer by a short branch, which, after crossing the Stort, will join at a new manhole in the London Road. After crossing the London Road the intercepting sewer will pass along the road to Twyford Bury, thence, leaving the road, will cross the Great Eastern Railway and pass through private land, skirting the western fence of the railway, to the footpath near the "Coach and Horses," along the footpath to the main road, and along the road through Spellbrook to the footpath leading to Tedmanbury Lock, along this footpath to the railway, and thence, skirting the railway, through private land to Kecksy's Bridge, thence following as near to the western side of the Stort Navigation as the land will permit to obtain cover for the sewer to Mill Hill, Sawbridgeworth, along Mill Hill to Bridgefoot, thence across private land by Bridgefoot Farm to the Sawbridgeworth Sewage Works, where the existing sewers from Sawbridgeworth will be connected.

From the Sawbridgeworth outfall the sewer will pass through private land, crossing Shearing Mill Lane and skirting round the hill to the junction of Springhall Lane with the footpath from Pishobury, along this path and Brook Road to the London Road, thence along the London Road and Rederick Lane nearly to the water works, thence through private land, crossing the Stort Navigation to the outfall site situate at the rear of Harlow Mill and to the north-east of the existing Harlow Sewage Works.

From Bishop's Stortfort to Sawbridgeworth the sewer will be 18in. in diameter, with an inclination of 1 in 1,000, and from Sawbridgeworth to the outfall 21in. in diameter, and 1 in 1,200 inclination.

Depth of sewer.

By reason of the rolling nature of the country to be traversed, the sewer is deep in several places, which occur, with one exception, in public roads. In Brook Road and London Road for a length of 1,170 yards it will be necessary to lay the sewer in tunnel, whilst the work continues deep nearly to Rederick Lane. We believe much of this deep work could be avoided, providing the sewer was brought through Pishobury Park from the bottom of Springhall Lane to the junction of Rederick Lane and London Road, and suggest, providing the owner will agree to accept a moderate sum for the easement, that this deviation be tried.

Specia constr at cro Stort Navig

Soon after leaving Rederick Lane the sewer comes out of ground, and will be carried across the low-lying land and the Stort Navigation in iron tube, supported on columns, at an elevation that will give adequate headway for the traffic on the Navigation to pass beneath without interruption.

Interc of Ha sewag

The sewage from Harlow will be brought to the outfall site by a short extension of the existing sewer, which will be connected close to the existing tanks at the rear of the gas works.

Ultim popula

The ultimate population (see Table No. 2) is taken at 24,286, being double the present.

Popul provid and di ing ca of sew Table

The sewers are designed to deal with the sewage derived from an ultimate population of 20,286 persons, being double the present population of Bishop's Stortford, Thorley, and Sawbridgeworth, as Harlow sewage is delivered separately at the outfall. When running full, the sewer will discharge the sewage from the population of 20,286, taken at 20 gallons per head, together with five times this quantity of rain or subsoil water.

The sewer will be low enough to drain all houses, except the mills and houses near Sawbridgeworth Railway Station and at Sheering Mill, but most of these are in the Parish of Sheering. If necessary, the sewage therefrom could be collected into a tank and pumped by a small gas engine into the main sewer.

Storm flows manh

Storm overflows will be placed in convenient positions, to discharge over fixed weirs, in order to prevent the sewer being overcharged, and manholes will be constructed at every change of direction and inclination.

Concr round

Where the sewer is in deep ground it will be surrounded with concrete to strengthen it.

Bisho Stortf sewers

The engineer to the Bishop's Stortford Urban District Council has furnished us with the result of the gaugings made in 1898 at the pumping station, which show that the daily flow amounted to 869,245 gallons. This quantity is so large for a population of about 7,000 persons that we asked him to gauge the flow at the manhole near South Mill Lock. This he did three times per day from 3rd to 7th June last, both days inclusive, with the result that after six hours' rain the quantity was 337 gallons per minute, or at the rate of 485,280 gallons in 24 hours, whilst the average flow was 385,920 in the same period, being at the rate of 268 gallons per minute. This average flow is about double what we should expect the dry weather flow to be, and the excess is due, in our opinion, to infiltration of subsoil water. Whether the scheme we are proposing is carried out or not, we strongly advise the Urban Council to have the sewers thoroughly examined, with a view of locating the defective lengths of sewer and having them repaired.

Land Outfa Work suffici ultima popula

The proposed site for the disposal of the sewage comprises the existing Harlow sewage land, No. 2, Parish of Latton, Ord. Survey $\frac{1}{2500}$ 1897 edition, together with the lower portion of the field situated between the gas works and Harlow Mill, and the field to the west, Nos. 69 and 68, Parish of Harlow respectively. The boundaries of the land proposed to be acquired are indicated on the plan, and the area thus shown is about 35 acres. We do not think so much land is absolutely necessary, but it is difficult, without going into the matter very exhaustively, to define the actual boundaries accurately, and we have therefore included more than sufficient land for treating the sewage of the ultimate population.

Soil.

The soil consists in the higher portions of loamy soil, sand, and gravel, and in the lower portions of loam, with possibly gravel under.

Sewag gravit to out No pu requir

The whole of the sewage will be delivered on to this site by gravitation at a level of about 143ft. above Ordnance datum; thus no pumping will be required, as the water level in the River Stort at this point is about 133ft. above Ordnance datum.

Popul provid in tan filters

Upon this site we propose to construct subsidence tanks and bacterial filters of sufficient capacity to treat the sewage from a population of 13,000 persons, being a little more than 10 per cent. increase above the present. When the population increases beyond this number additional tanks and filters can be constructed.

Subsi tanks.

On arrival at the outfall the sewage will be screened and then enter an open subsidence tank, which will have a capacity equal to one day's dry weather flow of sewage. Here subsidence will take place, and the sludge thus collected at the bottom will be drawn off as frequently as required, and disposed of upon a portion of the lower land. The tank will be divided into two. in order to allow the sludge being withdrawn without stopping the working.

From the tanks the clarified sewage will flow on to bacterial filters, composed of screened ballast and sand. These filters will be about 1 acre in extent, divided into eight beds. The beds will be fitted with automatic opening and discharging apparatus, and ample rest time given to each for aëration between the fillings.

The bacterial filters will treat the sewage and two equal volumes of rain or subsoil water, being 780,000 gallons in 24 hours. Any excess above this quantity will be so diluted that it can be run on plots of land reserved for dealing with storm waters.

The effluent from the filters will pass over land and thence into the river.

We estimate the cost of the proposed scheme as follows:—

Sewers, manholes, and outfall works - - - - -	£27,694 3 0
Engineering and supervision, 10 per cent. - - - -	2,769 17 0
	£30,464 0 0
Land and easements - - -	4,326 0 0
	£34,790 0 0

Annual amount to pay off loan and interest. Working expenses.

If this sum is borrowed at 3¼ per cent. for 30 years, the amount to be raised annually to pay off interest and principal in 30 equal instalments will be £1,844; to this must be added working expenses (£256), making a total of £2,100.

Rate required.

A penny rate (see Table No. 1) produces £248; therefore to raise £2,100 will necessitate an 8½d. rate for 30 years.

Apportionment of cost to each authority.

In our opinion, it will not be an equitable arrangement to charge each authority in proportion to their respective rateable values. It is clear Harlow is not interested in the sewer from Bishop's Stortford to the outfall, and that the dry-weather flow delivered to the outfall for treatment is largely augmented by the quantity of subsoil water coming from the Bishop's Stortford sewers. It must also be remembered that each authority, with the exception, perhaps, of Thorley, must in the near future incur considerable expenditure in establishing new outfall works—in some instances on fresh sites—the present not being suitable for modern requirements, nor situated properly in respect to the district to be served.

Suggested basis for apportioning cost.

We therefore suggest the proportions given in the table below as a basis to work upon. These figures are arrived at by assuming that Harlow should pay one-tenth, and the remaining 90 per cent. should be apportioned amongst the other three districts somewhat in proportion to their respective assessable values to Poor Rate:—

Proportional amount to be raised by each Authority of the total amount of 2,100*l.* required annually to pay off Loan with Interest and defray working expenses.

———	Percentage to be paid by each Authority of the total amount to be paid.	Annual payment by each Authority.	Annual rate required by each Authority.
		£.	*d.*
Bishop's Stortford - - - -	·72	1,512	11·28
Thorley - - - - - -	·05	105	4·20
Sawbridgeworth - - - -	·13	273	7·38
Harlow - - - - - -	·10	210	4·04
Total - - - £.	1·00	2,100	—

Note.—For amount produced by 1*d.* rate, *see* Table No. 1.

The following gives the rate required by each authority to pay for the working expenses at the existing works which are given in Table No. 1:—

Bishop's Stortford	£804 = 6*d.*	rate per annum.
Sawbridgeworth	£ 80 = 2·16*d.*	„ „
Harlow - -	£100 = 1·94*d.*	„ „

In addition, the existing farms at Bishop's Stortford and Harlow can be sold. Assuming they are sold for £100 per acre, then Bishop's Stortford will receive £10,300 and Harlow £600. Sawbridgeworth Farm is, we understand, rented only.

Estimated saving to rate by sale of existing farms.

If the money realised by the sale of the farms is put out to interest at 3¼ per cent., then Bishop's Stortford will receive £335 per annum, equal to a 2½d. rate, and Harlow £19 10s., equal to a ·38d. rate.

Net rate required by each authority to pay for works.

Therefore, the net amount to be paid by each authority will be:—

———	Total Rate.	Deduct for existing Rates saved.	Rate to be paid in addition to existing Rates.
	d.	*d.*	*d.*
Bishop's Stortford - - - -	11½	8½	3
Thorley - - - - -	4	—	4
Sawbridgeworth - - - -	7½	2¼	5¼
Harlow - - - - - -	4	2½	1½

The above arrangement appears unfavourable to Thorley and Sawbridgeworth, but it must be remembered that the former has incurred no expenditure, and the latter but little, for sewage disposal, and also that the rateable value of each will be increased when a main sewer is available. Thorley, in the near future, must adopt some scheme for treating the sewage from the houses in Thorley Street, etc.

Joint Board. If the scheme is adopted, a joint board should be formed, composed of representatives of the contributing authorities. This board would manage the outfall works and the intercepting sewer, leaving the internal drainage in the hands of the various District Councils.

Conclusion. In conclusion, we wish to thank the clerks and engineers to the various authorities for the information they have supplied and the assistance they have given us, and to assure the authorities if the above works are properly managed they will create no nuisance, and free the districts interested from all the trouble in respect of the effluent discharged into the river.

We shall be pleased to give further information, and attend upon the various boards, if required.

We are, Gentlemen,
Your obedient Servants,
C. N. Tween,
Engineer Lee Conservancy Board.

Pollard and Tingle, M.M.Inst.C.E.,
31, Old Queen Street,
Westminster, S.W.

TABLE No. 1.

Present Population, Area, and Cost of Working Farms, Rateable Value to District Rate and Amount produced by 1*d*. Rate.

	Population, 1901.	Area of Sewage Farms.	Annual Working Expenses at Outfall.	Rateable Value to District Rate.	Amount produced by 1*d*. to District Rate.	Assessable Value to Poor Rate.
		Acres.	£.	£.	£.	£.
Bishop's Stortford - -	7,143	103½	§804	33,513	134	41,471
Thorley (portion of) - -	*†500	- none -	—	†5,047	25	5,047
Sawbridgeworth - - -	2,086	Farm is rented	‡80	8,923	37	14,267
Harlow - - - - -	2,000	6	100	14,206	52	14,206
	11,729	—	984	—	248	—

* Estimated.

† For portion of parish abutting on main road between boundaries of Bishop's Stortford and Sawbridgeworth.

‡ Loss on land sublet.

§ Average for three years after deducting receipts from farm.

TABLE No. 2.

Ultimate Population. Quantity of Sewage. Discharge of Sewers.

	Ultimate Population.	Sewage 24 hours at 20 gallons per Head.	Mean flow of Sewage.	Cumulative mean flow.	Discharge of Sewer when running half full.	Diameter of Sewer.	Inclination.
			Gallons per Minute.	Gallons per Minute.	Gallons per Minute.	Inches.	
Bishop's Stortford - -	14,286	285,720	198	—	—	—	—
Thorley - - - -	2,000	40,000	28	226	—	—	—
					619	18	1 in 1,000
Sawbridgeworth - - -	4,000	80,000	56	282	—	—	—
	20,286	405,720	—	—	812	21	1 in 1,200
Harlow - - - - -	4,000	80,000	56	338	—	—	—
	24,286	585,720	338	—	—	—	—

LEE AND STORT VALLEYS MAIN SEWERAGE AND SEWAGE DISPOSAL SCHEME.

LEE CONSERVANCY.

REPORT and ESTIMATES on the LEE and STORT VALLEYS MAIN SEWERAGE and SEWAGE DISPOSAL, by C. N. TWEEN, Engineer, Lee Conservancy Board, and POLLARD AND TINGLE, MM.Inst.C.E., Westminster.

Lee Conservancy, 12, Finsbury Circus,
London, E.C., 7th October, 1903.

To the Chairman and Members of the Lee Conservancy Board.

Gentlemen,—

LEE AND STORT VALLEYS.

Main Sewerage and Sewage Disposal.

Referring to the resolution of the Board of the 6th February, 1903, together with previous resolutions, and to our reports to the Board of 1st May and 8th July, 1902, upon the interception and disposal of the sewage from the Lower Lee Valley, and from Bishop's Stortford to Harlow in the Stort Valley, respectively, we now have the honour to submit plans and sections, together with the following report and estimate for the interception and disposal of the sewage from the Lee and Stort Valleys:—

In our report of May, 1902, "Scheme B" consisted of intercepting the sewage in the Lee Valley, between Waltham Abbey and Cheshunt to Leyton, and conveying it to disposal works situated in the parish of Barking, the effluent after treatment being discharged into the River Thames at a point east of Barking Creek.

In the present report it is proposed to extend the intercepting sewer from Cheshunt up the Lee Valley to Hertford and the Stort Valley to Bishop's Stortford.

The present scheme is therefore an extension and adaptation of "Scheme B" up the Valleys of the Lee and Stort as far as Hertford and Bishop's Stortford, and an enlargement of the original sewer and outfall works to deal with the additional quantity of sewage intercepted.

The route of the sewer, together with the depths and sizes at the various points of intake, are shown upon the accompanying plans and sections.

From Barking to Cheshunt the route is the same as in "Scheme B." From Cheshunt the sewer is continued along the eastern side of the railway to the flood arches under the railway close to the junction of the Hertford Branch with the main line. Here the Stort Valley Sewer will come in. The sewer to Hertford will cross under the railway (main line) through one of the flood arches, and continue on the east side of the Hertford Branch to St. Margaret's, where it crosses to the west side, and follows the line to Ware. Here the line is crossed again and the sewer continued close to the railway, crossing under the New River and passing between the railway and the Brick Channel, carrying the effluent from the Hertford Sewage Works to its termination at those works.

The Stort Valley Sewer, from its junction with the Lee Valley Sewer near Broxbourne, crosses the Lee Navigation and Stort Navigation, and continues on the south and east sides of the railway (main line) through Roydon, Burnt Mill, Harlow, Sawbridgeworth, and Thorley to Bishop's Stortford, crossing the line at the level crossing carrying the road from Twyford Bury, and continuing along this road to the bottom of South Street, where the connection with the Bishop's Stortford sewers will be made.

The sewer commences at Hertford with a pipe 24in. in diameter, and at Bishop's Stortford with 21in. diameter. The diameter is increased at each intake until it becomes 8ft. between Walthamstow and Leyton. In each case the enlargement is made downwards, so that the full discharging capacity is given at the point of enlargement.

The sewer will be laid at a depth sufficient to allow the deepest sewer of the various authorities, whose sewage is intercepted, to deliver into it by gravitation at the springing level.

Manholes, side entrances, and storm overflows are provided where requisite, together with ventilating columns.

Cast-iron sewer through County of Hertford.

Throughout the County of Hertford the sewer is constructed in cast-iron pipes, the change to brick barrel surrounded with concrete being made in the parish of Enfield, where the branch sewer from Waltham Abbey and Cheshunt enters the intercepting sewer.

Site of pumping station.

In proximity to the existing Leyton Sewage Works it is proposed to acquire 6 acres of land upon which to erect a pumping station. This land is alongside the Temple Mills Sidings of the Great Eastern Railway, so that it will be an inexpensive matter to construct a siding into this site for the delivery of coal and stores.

Filth hoist.

At the end of the sewer a filth hoist will be erected for the purpose of screening the sewage before it reaches the pumps. The matter retained by the screen can be burnt so as to prevent any nuisance.

Reservoir for equalising flow.

The intercepting sewer will deliver into a reservoir, which will also receive the sewage of Leyton. The bottom of the reservoir will be 13ft. below the invert of the sewer. The reservoir is proposed so as to equalise to a certain extent the work of the pumps.

Rising main.

From the pumping station the sewage will be forced through a rising main, consisting of two rows of cast-iron pipes, each 42in. in diameter, to a chamber to be constructed in the new road at the north of the Leyton Electric Generating Station.

Gravitating outfall sewer.

At this chamber it is proposed to commence a gravitating sewer 102in. in diameter, which is continued to the disposal site at Barking by the route mentioned in "Scheme B," and as shown on the plans.

Special construction.

The special construction required, where the sewer is out of ground and the syphon across the Roding Valley, is shown on the plans and sections. The syphon will be constructed of two rows of cast-iron pipes, each 48in. in diameter. Sufficient head is given to secure a velocity through the syphon, which would be self-cleansing, and provision is made for emptying each pipe into the low level sewer of the Ilford Urban District Council, so that when necessary one length of pipe may be emptied and a man sent down to examine, clean, or repair.

Existing sewer from Leytonstone intercepted.

At the crossing of High Road at Harrow Green the existing sewer coming from Leytonstone will be connected with the sewage brought down by it to this point, intercepted, and conveyed in the outfall sewer by gravitation to Barking.

Capability of intercepting sewage from other parts of Leyton and Walthamstow.

As stated in the report on "Scheme B," it will be possible by constructing a subsidiary sewer to intercept the sewage from portions of Leyton and Walthamstow, and deliver it into the outfall sewer without pumping, but the cost of this subsidiary sewer is not included in the estimate

District served by intercepting sewer divided into "above" and "below" water company's intake.

The districts proposed to be served by the intercepting sewer may be grouped into two areas, the first being composed of those who deliver sewage effluent into the river above the intake of the East London Waterworks Company, and the second of those whose effluent reaches the river below such intake.

The first group consists of the districts to the north of Cheshunt, with the addition of Waltham Abbey and the Royal Small Arms Factory, and the second group of the districts to the south of Cheshunt.

The quantity of sewage and rainfall to be dealt with has been calculated on the following basis:—

District "above" intake. Quantity of sewage and rainfall.

For the districts above the intake, the dry weather flow of sewage is calculated at 25 gallons in 24 hours per head of population, and it is proposed to convey this quantity, together with five equal volumes of rainfall, making 150 gallons per head, to the disposal works, and there treat it from an ultimate population double that of the present, with the exception of Hoddesdon, Broxbourne, and Waltham Abbey, the ultimate population of each of these being taken as three times the present.

District "below" intake. Quantity of sewage and rainfall.

For the districts below the intake the dry weather flow of sewage is calculated at 25 gallons per head of population in 24 hours, and it is proposed to convey to the outfall works and treat three equal volumes of rainfall, making 100 gallons per head, from an ultimate population three times that of the present, with the exception of Leyton, where the ultimate is taken at double the present.

Tables.

Tables Nos. 1 and 2 give particulars of present population, dry weather flow of sewage, and total quantity of sewage and rainfall. Similar information for the ultimate population is given in Tables Nos. 3 and 4.

Table No. 5 gives the estimated quantity of sewage and rainfall that the intercepting sewer from Hertford to Barking will have to carry between each intake, together with the size and inclination of each section of the sewer and the level of the invert at each junction where it is proposed to intercept sewage.

Table No. 6 gives the particulars of the Stort Valley Sewer.

Sev car que sew rai ma pop

The sewers are designed to convey through the various sections the quantities shown against each in Tables Nos. 5 and 6—that is, from the ultimate population with the added volumes of rainfall as set out in Tables Nos. 3 and 4, and summarised below.

TOTAL Quantity of Sewage and Rainfall from *Ultimate Population*, conveyed through Sewers.

District.	Ultimate population	Dry weather flow gallons in 24 hours	Sewage and Rainfall gallons in 24 hours.
Above Intake - - -	108,100	2,702,500	16 215,000
Below Intake - -	867,200	21,680,000	86,720,000
	975,300	24,382,500	102,935,000

Quantity proposed to be pumped at present.

At the pumping station at Leyton, for present requirements, it is proposed to construct pumping plant capable of lifting the sewage and rainfall from the present population, with an increase of 10 per cent.

TOTAL Sewage and Rainfall from *Present Population* (*See Tables* No. 1 *and* 2).

District.	Present population.	Dry weather flow gallons in 24 hours	Sewage and Rainfall gallons in 24 hours.
Above Intake - - -	48,300	1,207,500	7,245,000
Below Intake -	322,400	8,060,000	32,240,000
	370,700	9,267,500	39,485,000

Ten per cent. increase added to the quantity of sewage and rainfall brings the total up to 43,433,500 gallons as the quantity to be pumped.

Machinery for present requirement.

Four engines and pumps capable together of lifting and forcing this quantity in 24 hours through the two rows of rising main will be provided, together with the requisite engine and boiler houses, boilers, and all supplementary machinery.

One engine and pump will be capable of dealing with the dry weather flow.

Machinery for ultimate population.

In order to deliver the 103,000,000 gallons per day from the ultimate population, 10 engines and pumps, each capable of lifting 10·3 million gallons in 24 hours would be required, and the rising main increased to a total of five rows of pipes, each 42in. in diameter, and the syphon to five rows of 48in. in diameter.

Storm overflows at Leyton and Walthamstow.

The lip of the weirs at the storm overflows at Leyton and Walthamstow, the two lowest on the intercepting sewer, are proposed to be constructed at a level of 17ft. above Ordnance datum.

Separate system of drainage.

Nearly the whole of the districts included in the present scheme are drained upon the separate system, the rainfall from the back roofs and paved yards at the rear only being admitted to the sewers.

Area of roofs and yards draining to sewer.

The average number of persons per house may be taken at five. Therefore, the present population, with 10 per cent. added, being 407,770 persons, the number of houses will be 81,554. Taking the area of the back roofs and paved yards at 1,000 square feet per house, the area delivering rainfall to the sewers for 81,554 houses will be 1,872 acres.

Storage capacity of sewer and reservoir.

Before the storm overflows came into action the sewer will be full for a considerable distance. The storage capacity of sewer and reservoir up to the level of the weir of the overflow is 6,600,470 gallons.

Tir ove wit fall in

With rain falling at the rate of 1in. in 24 hours over the whole of the district, and the sewer receiving the sewage from a population of 407,770, being 10 per cent. more than the present, and the rainfall from the 81,554 houses or 1,872 acres, it will be 16¾ hours before the storm overflows come into action, providing the four pumps are kept running.

Outfall Works.

It is proposed to acquire an area of 230 acres, as shown in the plan, for the purpose of carrying out the work of purifying the sewage.

The soil is generally light loam on the surface, with a gravel subsoil.

It is proposed to construct open subsidence tanks of sufficient capacity to contain half the daily dry weather flow from a population of 407,770, being an increase of 10 per cent. on the present. The sludge obtained from the subsidence in these tanks will be withdrawn as it becomes necessary, and by means of compressed air be forced over the land and there disposed of, or through a cast iron main into barges on the Thames, to be carried away and discharged near the mouth of the river.

In the estimate we have not allowed for the cost of barges, as we think the land will dispose of the sludge for many years without creating any nuisance.

The sewage will pass over a weir from these tanks on to a series of artificial filters. These filters will be constructed of concrete and filled with the material excavated during their construction after it has been screened.

The beds will be filled and emptied in succession automatically twice in the 24 hours, sufficient time being given for aëration between the fillings.

The effluent water, upon leaving the filters, will be delivered through a cast iron pipe into the River Thames below low water.

The level of the outlet from the filters is 16ft. above Ordnance datum. They will, therefore, discharge at any state of the tide.

From our experience elsewhere, it is anticipated that this treatment will remove the whole of the suspended matter in the sewage, and that a purification of about 80 per cent. will be obtained uniformly. This we consider sufficient, as the effluent enters a large body of tidal water. The area of land proposed to be acquired will permit of the extension of the tanks and filters as it may become necessary from the increase of the population. There is also a large area of land in the immediate neighbourhood that could be acquired and made available for the disposal of additional sewage if required at any future time.

Estimate.

An estimate of cost is given, amounting to £1,066,044 for works, machinery, land, easements, engineering, and cost of Act.

If this sum is borrowed for 60 years (machinery for 30 years) at 3¼ per cent., and paid off in equal annual instalments of principal and interest, the amount required per annum will be £41,346, equal to a 7·78d. rate on the present ratable value. The working expenses are estimated at £14,000 per annum, necessitating a 2·63d. rate.

Tables No. 7 and 8 give the rateable value of each district, and the amount produced by a 1d. rate to general district rate, a summary of which is given below.

——	Assessable Value to District Rate.	Amount produced by 1d. rate.
	£.	£
Total for districts "above" Water Co.'s. Intake.	213,437	855
Total for districts "below" Water Co.'s Intake.	1,214,661	4,462
Total for both districts -	1,428,098	5,317

The rate required to repay the loan and interest in equal annual instalments and the working expenses, the interest being 3¼ per cent. per annum if the loan is borrowed for the following periods, will be:—

Period for which loan borrowed.	Rate required annually.
60 years - - - -	10½*d.*
50 years - - - -	11*d.*
40 years - - - -	11¾*d.*
30 years - - - -	13¼*d.*

It must be borne in mind that if this scheme be adopted, each authority will be relieved of all expense at their existing pumping stations and outfall works, and the land now used as farms can be disposed of.

Saving to Authorities by extinction of present expenses at Outfall Works, &c., &c.

In addition, the intercepting drain from Ponder's End, the portion of the river flowing from Tottenham through Hackney and the London County Council's recreation ground at Hackney Marshes, together with the streams running through West Ham, will, by reason of the interception of the sewage, and the abolition of the existing large sewage farms which at present discharge sewage effluent into them, be freed from contamination, and their waters purified.

With regard to the time required for the construction of the works, after the Act is obtained, three years will be sufficient, provided the contract is split up into sections, and these sections proceeded with concurrently.

In conclusion, we wish to thank the clerks and engineers of the various authorities for the information and assistance they have given us, and to assure the Board we shall be pleased to give further particulars if required.

C. N. Tween,
Engineer Lee Conservancy Board.

Pollard and Tingle, M.M.Inst.C.E.
31, Old Queen Street, Westminster.

TABLE No. 1.

Particulars of Present Population and Quantity of Sewage derived therefrom, calculated at 25 gallons per head, Dry Weather Flow, for the Districts whose effluents flow into the River Lee, above the intake of the East London Water Company. Total flow, including rainfall being calculated at 6 volumes of the Dry Weather Flow.

——	1. Population, 1901.	2. Dry Weather Flow, 24 hours at 25 gallons per head.	3. Total Quantity of Sewage and Rainfall in 24 hours = 6 volumes of D.W.F.
		Gallons.	Gallons.
Bishop's Stortford - - - - - - -	7,200	180,000	1,080,000
Thorley - - - - - - - - -	500	12,500	75,000
Spellbrook and Hallingbury - - - - -	500	12,500	75,000
Sawbridgeworth - - - - - - - -	2,000	50,000	300,000
Harlow - - - - - - - -	2,000	50,000	300,000
Roydon, Netteswell, &c. - - - - - -	2,000	50,000	300,000
Hertford - - - - - - - - -	10,000	250,000	1,500,000
Ware - - - - - - - - - -	5,600	140,000	840,000
Stanstead Abbots and St. Margarets - - - -	2,000	50,000	300,000
Hoddesdon - - - - - - - - -	5,000	125,000	750,000
Broxbourne - - - - - - - - -	1,000	25,000	150,000
Wormley - - - - - - - - -	1,000	25,000	150,000
Waltham Abbey - - - - - - - -	6,500	162,500	975,000
Royal Small Arms Factory - - - - -	3,000	75,000	450,000
	48,300	1,207,500	7,245,000

TABLE No. 2.

Particulars of Present Population and Quantity of Sewage derived therefrom, calculated at 25 gallons per head Dry Weather Flow, for the districts whose effluents flow into the River Lee below the intake of the East London Water Company. Total flow, including Rainfall, being calculated at four volumes of the Dry Weather Flow.

——	1. Population, 1901.	2. Dry Weather Flow, 24 hours at 25 gallons per head.	3. Total Quantity of Sewage and Rainfall in 24 hours = 4 volumes of D.W.F.
		Gallons.	Gallons.
Cheshunt	13,000	325,000	1,300,000
Enfield	43,000	1,075,000	4,300,000
Edmonton and Southgate	62,000	1,550,000	6,200,000
Chingford	4,400	110,000	440,000
Walthamstow	100,000	2,500,000	10,000,000
Leyton	100,000	2,500,000	10,000,000
	322,400	8,060,000	32,240,000

TABLE No. 3.

Particulars of ultimate Population and Quantity of Sewage derived therefrom, calculated at 25 gallons per head, Dry Weather Flow, for the Districts whose effluents flow into the River Lee, above the intake of the East London Water Company. Total flow, including Rainfall, being calculated at six volumes of the Dry Weather Flow.

——	1. Ultimate Population.	2. Dry Weather Flow, 24 hours at 25 gallons per head.	3. Total Quantity of Sewage and Rainfall in 24 hours = 6 volumes of D.W.F.
		Gallons.	Gallons.
Bishop's Stortford	14,400	360,000	2,160,000
Thorley	1,000	25,000	150,000
Spellbrook and Hallingbury	1,000	25,000	150,000
Sawbridgeworth	4,000	100,000	600,000
Harlow	4,000	100,000	600,000
Roydon, Netteswell, &c.	4,000	100.000	600,000
Hertford	20,000	500 000	3,000,000
Ware	11,200	280,000	1,680,000
Stanstead Abbots and St. Margarets	4,000	100,000	600,000
Hoddesdon	15,000	375,000	2,250,000
Broxbourne	3,000	75,000	450,000
Wormley	2,000	50,000	300,000
Waltham Abbey	19,500	487,500	2,925,000
Royal Small Arms Factory	5,000	125,000	750,000
	108,100	2,702,500	16,215,000

TABLE No. 4.

Particulars of ultimate Population and Quantity of Sewage derived therefrom, calculated at 25 gallons, per head, Dry Weather Flow, for the Districts whose effluents flow into the River Lee, below the intake of the East London Water Company. Total flow, including Rainfall, being calculated at four volumes of the Dry Weather Flow.

——	1. Ultimate Population.	2. Dry Weather Flow, 24 hours at 25 gallons per head.	3. Total Quantity of Sewage and Rainfall in 24 hours = 4 volumes of D.W.F.
		Gallons.	Gallons.
Cheshunt	39,000	975,000	3,900,000
Enfield	129,000	3,225,000	12,900,000
Edmonton and Southgate	186,000	4,650,000	18,600,000
Chingford	13,200	330,000	1,320,000
Walthamstow	300,000	7,500,000	30,000,000
Leyton	200,000	5,000,000	20,000,000
	867,200	21,680,000	86,720,000

TABLE No. 5.

LEE VALLEY SEWER.

Particulars of Sewers, and of Total Quantity of Sewage and Rainfall from ultimate Population

Sewer from	Total flow from ultimate population in 24 hours. See Tables Nos. 3 and 4. Column No. 3.	Diameter of Sewer.	Inclination.	Level of invert at intake in feet above O.D.
	Gallons.	Inches.		
Hertford to Ware - - - - - -	3,000,000	24	1 in 700	Hertford - 109·00
Ware to Stanstead - - - - - -	4,680,000	27	1 „ 1000	Ware - - - 95·00
Stanstead to Hoddesdon - - - - -	5,280,000	30	1 „ 1000	Stanstead - - 85·22
Hoddesdon to Junction with Stort Valley Sewer	7,530,000	33	1 „ 1000	Hoddesdon - - 76·75
Junction with Stort Valley Sewer to Broxbourne	11,790,000	42	1 „ 1100	Stort Junction - 75·75
Broxbourne to Wormley - - - - -	12,240,000	48	1 „ 1200	Broxbourne - 64·74
Wormley to Cheshunt - - - - -	12,540,000	48	1 „ 1200	Wormley - - 62·50
Cheshunt to Royal Small Arms Factory - -	19,365,000	51	1 „ 1000	Cheshunt - - 41·13
Royal Small Arms Factory to Enfield - -	20,115,000	51	1 „ 1000	R.S.A.F. - - 36·00
Enfield to Edmonton - - - . - -	33,015,000	60	1 „ 1000	Enfield - - 26·50
Edmonton to Chingford - - - - -	51,615,000	84	1 „ 2000	Edmonton - - 17·20
Chingford to Walthamstow - - - -	52,935,000	84	1 „ 2000	Chingford - - 12·58
Walthamstow to Leyton - - - - -	82,935,000	96	1 „ 2000	Walthamstow - 6·72
Leyton to Barking - - - - - -	102,935,000	102	1 „ 2640	Leyton - - 3·01

TABLE No. 6.

STORT VALLEY SEWER.

Particulars of Sewers, and of Total Quantity of Sewage and Rainfall from ultimate Population.

Sewer from	Total flow from ultimate population in 24 hours. See Tables Nos. 3 and 4. Column No. 3.	Diameter of Sewer.	Inclination.	Level of invert at intake in feet above O.D.
	Gallons.	Inches.		
Bishop's Stortford to Sawbridgeworth - -	2,460,000	21	1 in 726	Bishop's Stortford 175·00
Sawbridgeworth to Harlow - - - - -	3,060,000	24	1 „ 750	Sawbridgeworth - 144·75
Harlow to Roydon - - - - - -	3,660,000	27	1 „ 800	Harlow - - 131·31
		27	1 „ 600	Burnt Mill - - 119·31
Roydon to Junction with Lee Valley Sewer -	4,260,000	27	1 „ 500	Roydon - 93·22
		30	1 „ 900	Junction - - 75·75

TABLE No. 7.

Particulars of Rateable Value and Amount produced by 1*d*. Rate, for the Districts whose effluents flow into the River Lee above the intake of the East London Water Company.

—	County Rate Valuation.	Assessable Value to District Rate or on Special Expenses Basis.		—
	Assessable Value.	Assessable Value.	Amount produced by 1d. rate.	
	£.	£.	£.	
Bishop's Stortford	37,609	33,513	134	
Thorley	5,727	5,047	25	
Sawbridgeworth	13,824	8,923	37	
Harlow	12,692	14,206	52	
Netteswell	4,916	2,409	10	
Roydon	11,296	5,000*	21*	*Estimated.
Hertford	48,137	39,710	165	
Ware	27,703	26,270	109	
Stanstead Abbots	8,240	5,912	24	
St. Margarets	2,291	1,952	8	
Hoddesdon	27,041	26,643*	111*	*Estimated.
Broxbourne	11,009	6,905	29	
Wormley	6,193	3,856	16	
Waltham Abbey	41,976	33,091	114	
	258,654	213,437	855	

NOTE.—Nothing has been included for the Royal Small Arms Factory as rateable value, though doubtless the War Department would make a contribution to the Capital cost of the works and pay an annual amount for working expenses.

TABLE No. 8.

Particulars of Rateable Value and Amount produced by 1*d*. Rate for the Districts whose effluents flow into the River Lee below the intake of the East London Water Company.

—	County Rate Valuation.	Assessable Value to District Rate, or on Special Expenses Basis.	
	Assessable Value.	Assessable Value.	Amount produced by 1*d*. Rate.
	£.	£.	£.
Cheshunt	73,056	44,448	175
Enfield	218,306	172,890	660
Edmonton	175,244	164,344	580
Southgate	105,221	99,096	355
Chingford	23,648	23,733	99
Walthamstow	337,076	312,537	1,224
Leyton	397,613	397,613	1,369
TOTAL	1,330,164	1,214,661	4,462

ESTIMATE.

Estimate of Cost and of the Annual Sum to be raised, with amount of Rate in the £ to defray the same, for Main Intercepting Sewer for the Lee Valley and the Stort Valley, delivering to Disposal Works, and discharging the effluent after treatment into the River Thames to the East of Barking Creek.

—	Estimate of Cost.	Annual Sum and Rate required to pay off Loan in equal annual instalments of Principal combined with Interest.			
		If Loan is borrowed for 30 years at 3¼ per cent.		If Loan is borrowed for 60 years at 3¼ per cent.	
		1.	2.	3.	4.
		Annual Sum to be raised to repay Loan and Interest and defray Working Expenses.	Rate in the £ (on assessable value to District Rate as on Lady Day, 1902) to be levied annually to meet sums required, as set out in Column 1.	Annual Sum to be raised to repay Loan and Interest and defray Working Expenses.	Rate in the £ (on assessable value to District Rate as on Lady Day, 1902) to be levied annually to meet sums required, as set out in Column 3.
	£. s. d.	£. s. d.	d.	£. s. d.	d.
Main Sewer, Rising Main, Engine and Boiler Houses, including 5 per cent. for contingencies.	717,476 – –	—	—	—	—
Tanks, Filters and Effluent Pipe	128,780 – –	—	—	—	—
Engineering Supervision, Cost of Act, &c.	60,000 – –	—	—	—	—
Land and Easements - - -	109,788 – –	—	—	—	–
	1,016,044 – –	53,444 – –	10·05	38,711 – –	7·28
Machinery - - - - -	50,000 – –	2,635 – –	·50	*2,635 – –	·50
	1,066,044 – –	56,079 – –	10·55	41,346 – –	7·78
Working Expenses - - - - - - -		14,000 – –	2·63	14,000 – –	2·63
		70,079 – –	13·18	55,346 – –	10·41
			Total Rate per annum = 13¼*d.*		Total Rate per annum = 10½*d.*

* *Note.*—A Loan for Machinery would only be sanctioned for 30 years.

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ROYAL COMMISSION ON SEWAGE DISPOSAL.

FOURTH REPORT

OF

THE COMMISSIONERS

APPOINTED IN 1898

TO INQUIRE AND REPORT WHAT METHODS OF

TREATING AND DISPOSING OF SEWAGE

(Including any Liquid from any Factory or Manufacturing Process)

MAY PROPERLY BE ADOPTED.

POLLUTION OF TIDAL WATERS,

WITH SPECIAL REFERENCE TO

CONTAMINATION OF SHELL-FISH.

VOLUME III.

REPORTS BY DR. HOUSTON ON BACTERIOLOGICAL INVESTIGATIONS.

CORRESPONDENCE WITH FOREIGN COUNTRIES.

Presented to both Houses of Parliament by Command of His Majesty.

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SHELL-FISH INQUIRY

Report on the Bacteriological Examination of Estuarial Waters and Shell-Fish.

By Dr. A. C. Houston.

This report is, for convenience, arranged in five divisions.

Division I. deals with the bacteriological examination of the River Thames and Thames Estuary.

It comprises the bacteriological examination of :—

> (1.) The water of the River Thames at Sunbury and Hampton, above the intakes of some of the London Water Companies. (2.) Filtered water as supplied to the consumers by the Southwark and Vauxhall and by the East London Water Works Companies. (3.) The sewage effluents discharged into the Thames at Barking and Crossness. (4.) The River Thames at *(a)* Barking, and at *(b)* Crossness; at *(c)* Purfleet; at *(d)* Grays; at *(e)* Mucking; and *(f)* at the Chapman Lighthouse. Also, (5.) the bacteriological testing of *(a)* the Barking and Crossness chemically-precipitated sludge, and *(b)* the water in the Barrow Deep into which this sludge is discharged.

Division II. deals with the artificial addition to sewage of B. pyocyaneus, with observation of the passage of this microbe through a continuous filter bed, as also through a septic tank and contact beds.

> [Observations on B. pyocyaneus are included with results of the shell-fish inquiry because it is too commonly assumed that the complete solution of the problem of securing shell-fish against undesirable contamination lies in the treatment of sewage about to be discharged into estuaries by one or another of the bacteria bed processes at present in vogue.]

Division III. deals with the bacteriological examination of samples from the surface of deep sea water at a distance from land, the division of estuarial waters into classes, and the difficult question of standards.

Division IV. deals with the comparison bacteriologically of water and oysters obtained from a river (Helford River), which, on topographical grounds, would be regarded as unobjectionable, with water and oysters from a river (Penryn River), which, from the topographical point of view, would be considered definitely polluted. Here also the question of standards is dealt with in relation to oysters, and oysters are, *qua* bacteriological facts, arranged in a series of classes.

Division V. includes a large number of observations in connexion with the shell-fish inquiry, of which the following is a brief summary :—

Appendix A.

The results of the bacteriological examination of numerous chance samples of estuarial and other waters, collected for the most part during the visits paid by the Commission to various centres of the oyster industry.

Appendix B.

A series of experiments dealing with the bacteriological examination of deep sea oysters, and samples of surface sea water collected over the oysters.

Appendix C.

Experiments dealing with the bacteriological examination of four samples of oysters, and of sea water, obtained from each of the following sources :—Whitstable, West Mersea, Crouch, Roach, and Pyfleet Layings.

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A series of experiments dealing with the bacterial contents individually of ten oysters in each instance, out of batches of oysters derived from diverse localities.

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A series of experiments dealing with the effect of exposure of the bodies of oysters, after removal from their shells, to various germicidal solutions.

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APPENDIX K.

Experiments designed to discover how long B. coli or coli-like microbes persist in oysters stored under experimental conditions.

APPENDIX L.

A series of experiments dealing with the results of the bacteriological examination of oysters as placed on the market for sale.

Before proceeding to describe the results of the investigations under the foregoing headings, and incidentally to record provisional inferences on the facts observed, it may be urged that, in considering the matters reported on, attention be given less to detectable inadequacy of bacteriology in affording definite and conclusive reply to the difficult problems set the bacteriologist than to certain broad indications which seem to suggest that bacteriology is destined eventually to play an important part in influencing administrative procedure in cases of pollution obscure to the topographist. As regards inferences from the facts that will come under review, it may be confessed that difficulty was experienced, as time went on, in avoiding to the extent that could be wished that "enthusiasm of results" which is apt to beset the zealous worker; and accordingly, it is proper that the data should be judged apart altogether from the personal opinions of the writer. Nevertheless, it is anticipated that in the not distant future bacteriology will yield, in the matter of shell fish and allied public health questions, service of value not less direct and satisfactory than that already rendered by it in advancement of the sciences of medicine and surgery.

So far as the present observations have gone, samples taken at the surface of deep sea water at a distance from land and remote therefore from sewage pollution, do not contain B. coli or coli-like microbes,* and, putting aside certain anomalous cases, the same would seem to be true of deep sea oysters. On the other hand, samples of tidal waters and of oysters from localities to which on topographical grounds objection could not reasonably be made, do, as matter of fact, commonly contain B. coli or coli-like microbes.

Clearly, therefore, more extended observations are needed before a bacteriological standard can properly be adopted.

In making such observations it is essential, I think, that the analysis should be quantitative as well as qualitative, and that the operations should be on a much wider basis than has yet been attempted.

At present, in many instances at least, the results of a bacteriological examination must be interpreted in the light of topographical obervations.

Passing now to facts observed and considerations reported, it may be noted in the *first place* that alarm *need not arise* from proof of the presence of seemingly objectionable microbes in practically all the oysters, individually and collectively tested, from well nigh every oyster laying under examination. And the like is true as regards the water over and about oyster layings. Obviously, if all oysters normally contain microbes which have been regarded as objectionable, to impugn either water or oyster layings owing to the *mere presence* of microbes of reputedly undesirable sort, irrespective of their relative abundance and their pathogenicity for the human subject, and without any knowledge of local conditions in their bearing on epidemiological experience, would be without sufficient warrant.

Secondly, it may be pointed out that the grouping of waters and of oysters into classes, which has been adopted, does not necessarily imply acceptance of any standards, and, by inference therefrom, determination of degrees of biological impurity which may be permitted as consistent with the fattening or the storage of the oysters tested having been such that they may be trusted to continue to prove not only palatable but wholesome.

Thirdly, it must be understood that any standards, whether for water or for oysters which are suggested or favoured, must needs be regarded as merely tentative. Such provisional standards rest on a number of experiments, limited by the time available for the investigation, and are not therefore, it is admitted, *to be trusted as bases for administrative action.* Nevertheless, these standards may meanwhile serve a useful purpose, for the following reasons. Some persons can think in figures automatically with the same facility, for instance, that others can think in one or other foreign language. Whereas not a few of us have, in entertaining new considerations, consciously to make comparison of them with old facts stored as it were in our cerebral pigeon holes. In this sense especially, the grouping into classes of waters and of oysters that has been tentatively adopted may not come amiss to fellow workers as quasi standards for the purpose of instituting comparisons. To cite a chemical parallel: Chemists are not generally agreed as to the precise value to be attached to the "Mersey and Irwell Standard." Nevertheless, many chemists mentally refer, wittingly or unwittingly, to that standard in judging of facts they themselves are obtaining in chemical examination of sewage and effluents.

Lastly, in further extenuation, if need be, of the attitude taken towards work accomplished, it may be observed that no bacteriologist who aspires to be more than a purveyor of facts, who has, for instance, been in the habit of giving thought to the bearing of the results which he obtains on current problems of preventive medicine, can refrain from drawing inferences more or less speculative in character. Such inferences, however much they may be open to criticism, and, as a consequence, have to be disregarded for administrative or other reasons, may, nevertheless, be not without their value as possible stepping stones to further advance of knowledge.

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* The precise significance to be attached to the presence of coli-like microbes in a water may be matter for dispute; but in this connexion it is of interest to note that before the Court of Arbitration now sitting to assess the value of the undertakings of the several London Water Companies, the experts retained by the Metropolitan Water Board based their views as regards inadequate filtration of certain of the Companies' waters on the presence in the filtered water of coli like microbes as well as of typical B. coli. This matter is amplified in several sections of this report.

In the following pages temptation to trespass beyond the limits of a fair interpretation of the facts will be studiously resisted. Nevertheless, in drawing inferences from the results obtained, the expression of personal conviction of the future, if not present, practical utility of the bacteriological testing of estuarial water and of oysters cannot honestly be suppressed.

During this inquiry my colleague, Dr. Gordon, has kindly relieved me of much of the responsibility of the routine work in connection with the examination of artifical processes of sewage disposal.

This has set free Miss Power and Miss Hartley, and during a portion of the time Miss Chick, to render me their efficient help, which is here most gratefully acknowledged. In connexion with the examination of the oysters, the heaviest burden of work has, perhaps, fallen to Miss Hartley's lot, and the practical value of her services has been great.

Acknowledgment must here be made of the work carried out by other bacteriologists in reference to the question of the pollution of shell-fish. While attempting to place a fresh interpretation on old facts, or endeavouring to pave the way towards future knowledge, it is fully appreciated how greatly the work of other men has provided the lever operating in the direction of progress. Among the bacteriologists in this country who have devoted much time and attention to the subject the names of Boyce, Buchanan, Foulerton, Herdman, Hewlett, Klein, Lorrain Smith, McWeeney, Scholberg, and Thresh must be mentioned. Dr. McWeeney's report will, I think, be duly recognised as the first serious attempt to link together in a successful manner bacteriological facts with topographical observations.

I have experienced great kindness and willing help at the hands not only of the officers of the large oyster companies but the owners of private layings, for which I am most grateful.

No scientific report on shell-fish would be complete without allusion to Dr. Bulstrode's classical report on Oyster Culture in relation to Disease. It suffices to say that its practical value in the present investigation has been very great. I have quoted from it freely, and copied many of its instructive maps. Throughout the investigation this report has proved a constant guide and a most valuable source of information.

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The Bacteriological Examination of the River Thames and the Thames Estuary.

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The Bacteriological Examination of the River Thames and the Thames Estuary.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

INTRODUCTORY.

To study the bacteriology of the River Thames and the Thames Estuary in an exhaustive manner would occupy the attention of many observers for a prolonged period. As the Commission wished to obtain certain information within a limited space of time, it became necessary to concentrate the work in directions most likely to yield results of value.

On pages 62 and 66 respectively, the Results and Conclusions are summarised.

The lines of investigation may be briefly summarised as follows :—

Lines of Investigation.

Section I.—The condition of the River Thames at Hampton and Sunbury above the tidal portion of the river and above the intakes of some of the London Water Companies.

Section II.—The condition of the Barking (Northern outfall) and Crossness (Southern outfall) chemical effluents.

Section III.—The biological qualities of the Barking (Northern outfall) and Crossness (Southern outfall) chemically precipitated sludge.

Section IV.—The condition of the River Thames at high and low tide opposite the Northern outfall at Barking.

Section V.—The condition of the River Thames at high and low tide opposite the Southern outfall at Crossness. About two miles below Barking.

Section VI.—The condition of the River Thames at high and low tide at Purfleet. About five miles below Crossness.

Section VII.—The condition of the River Thames at high and low tide at Grays. About 10 miles below Crossness.

Section VIII.—The condition of the River Thames at high and low tide at Mucking. About 20 miles below Crossness.

Section IX.—The condition of the River Thames at high and low tide at the Chapman Lighthouse. About 25 miles below Crossness.

Section X.—The condition of the water in Barrow Deep, which receives weekly 50,000 tons of sludge from the Northern (Barking) and Southern (Crossness) outfall works. The entrance to Barrow Deep is about 48 miles from Crossness.

Section XI.—The bacteriological examination of London filtered water (examples, East London and Southwark and Vauxhall Water Companies). For comparative purposes.

I am greatly indebted to the officials of the London County Council and Trinity House and the Captain Superintendents of the Training Ships at Purfleet and Grays for their kindness in the matter of the collection and transmission of samples, and for many valuable suggestions in connection with the work.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Number of Samples.

The samples were two hundred and sixty-five in number, and they may be grouped under the various sections as follows:—

Section I	36	samples
,, II	16	,,
,, III	8	,,
,, IV	24	,,
,, V	18	,,
,, VI	33	,,
,, VII	36	,,
,, VIII	26	,,
,, IX	20	,,
X	28	,,
,, XI	20	,,
TOTAL	265	samples.

Whenever practicable samples were collected at high and at low tides and in mid-stream. It would have been of interest to examine average samples, surface and deep samples, and samples collected at different points across the river. But this, as also an examination of the mud and banks of the river, could not be attempted within the limits of the investigation.

Tests employed.

The tests on which reliance were placed during the course of the investigation were:—

B. Coli test:—

The approximate number of gas-forming coli-like microbes present in the various samples was not only determined, but in each case the biological characters of the *strain* of B. coli on which the numerical estimation is based were also studied and are given in the tables.* It is perhaps hardly necessary to add that in all cases the coli-like microbes were isolated in *pure* culture before determining their biological characters. The word "*communis*" has not been used, for the reason that unaccompanied by any definite statement that in each case certain specified tests were employed, with in each case a satisfactory result, the term is of doubtful value, and may be misleading. If the numerical estimation of the coli-like microbes is always accompanied with a detailed account of the results of their subculture, the term "*communis*" is unnecessary. *Throughout this Division the term B. coli has been used to include all gas-forming coli-like microbes. The biological attributes of these microbes are invariably given in the respective tables.*

B. Enteritidis sporogenes test:—

The results are based on the smallest amount of the sample yielding positive results as regards the "enteritidis change" in anaerobic milk cultures for spores. Animal inoculation experiments were not carried out, but as has been pointed out again and again the "enteritidis change" in milk culture, apart from any test for virulence of culture, has usually a pathological significance. In any case the test, *as a test*, is of great value in enabling a wide biological difference to be drawn between sewage and pure water. At the risk of dwelling unduly on an established fact, it may be pointed out that hundreds of samples of crude sewage yield a positive result as regards the "enteritidis change" in milk culture with one-hundredth to one-thousandth c.c. of sewage, and that hundreds of samples of pure water give a negative result with 10 to 100 c.c. or more of pure water.

The value of the test in the present enquiry will, I think, be obvious to anyone who reads the report.

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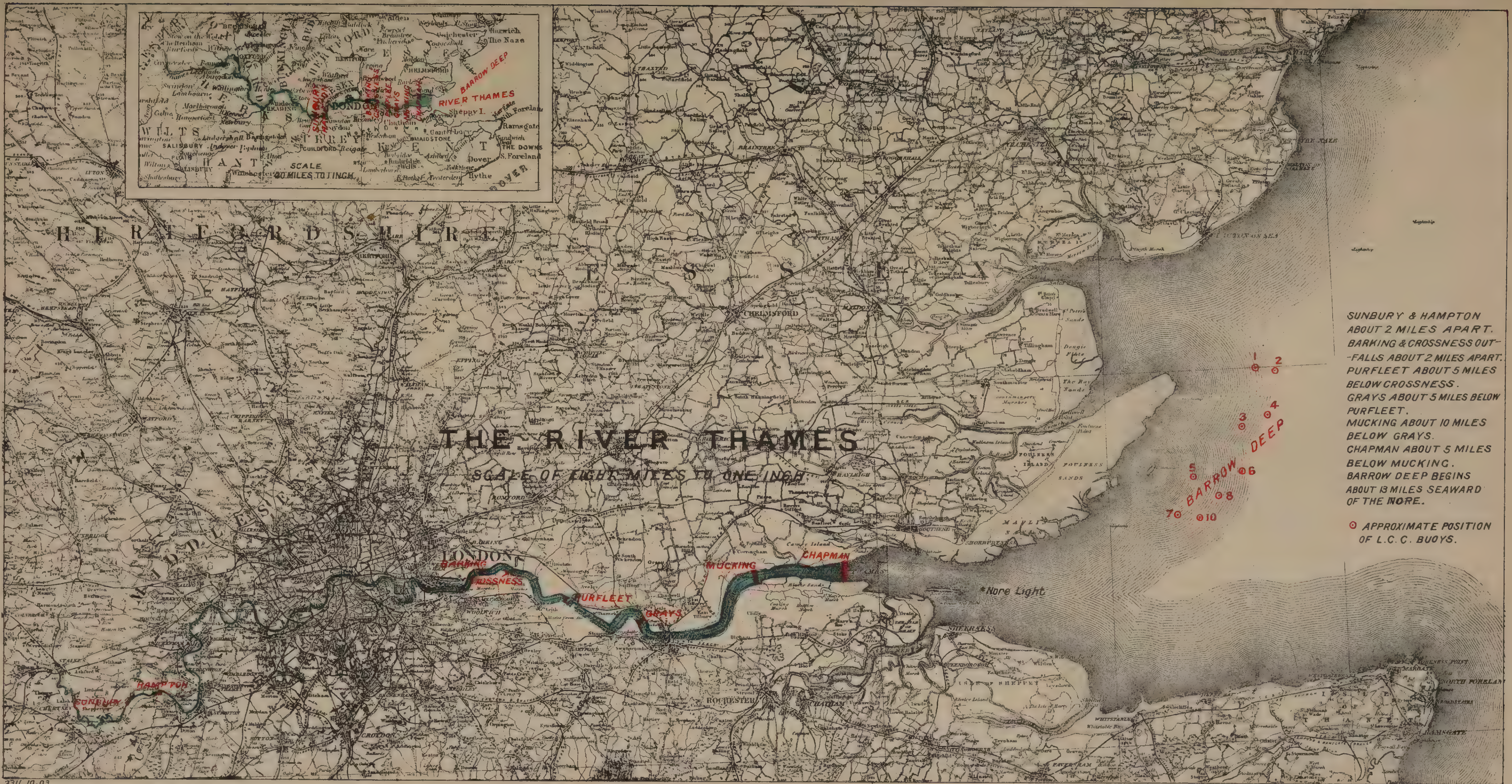
* It will, of course, be understood that throughout this Report, and whether dealing with water or with oysters, if B. coli or coli-like microbe are isolated from a known fraction of a cubic centimetre of these substances, the results are expressed as number of B. coli or of coli-like microbes (as the caae may be) per cubic centimetre of water or oysters by a simple process of multiplication.



THE RIVER THAMES

SCALE OF EIGHT MILES TO ONE INCH

SUNBURY & HAMPTON ABOUT 2 MILES APART.
BARKING & CROSSNESS OUT-FALLS ABOUT 2 MILES APART.
PURFLEET ABOUT 5 MILES BELOW CROSSNESS.
GRAYS ABOUT 5 MILES BELOW PURFLEET.
MUCKING ABOUT 10 MILES BELOW GRAYS.
CHAPMAN ABOUT 5 MILES BELOW MUCKING.
BARROW DEEP BEGINS ABOUT 13 MILES SEAWARD OF THE NORE.

⊙ APPROXIMATE POSITION OF L.C.C. BUOYS.

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Division I.
Bacteriological Examination of the River Thames and Thames Estuary.

*Lactose, peptone, sodium carbonate, milk test :—**

A positive result with this test is evidenced by gas formation, acid production, and clotting of the medium within 48 hours at 37°C. This test is a useful, and like the neutral red broth test measures with *relative* certainty the number of coli-like microbes present in a sample, provided the *smallest* amount of the liquid yielding a positive result is noted. It is assumed that coli-like microbes are present in much greater abundance than the spores of bacteria. When the spores of bacteria are numerous, a parallel abundance of B. coli cannot, however, with safety be inferred. But in any case fæcal contamination, although not necessarily of *recent* sort, may still be suspected, and certainly the presence in any number of spores capable of producing gas, acid and clot in this medium is an objectionable indication. Discrimination and knowledge are needed in interpreting the results obtained with this as with all other simple tests. So far as my experience goes, the lactose-peptone-milk, bile-salt-glucose-peptone, neutral red broth and indol tests all yield broadly parallel results when properly applied in the bacteriological examination of fæces, sewage, sewage effluents, and polluted waters.

Neutral red broth test :—

A positive result with this test is evidenced by development in the medium of greenish-yellow fluorescence within 48 hours at 37°C. The neutral red broth tubes should always be heated to 100°C. for a quarter to half an hour and then rapidly cooled in cold water before use. It will be found convenient to employ 6 in. × $\frac{1}{2}$ in. test tubes.

For further details my Report on Methods may be consulted.†

Section I.—*The condition of the River Thames at Hampton and Sunbury above the tidal portion of the river, and above the intakes of some of the London Water Companies.*

Sunbury and Hampton are about two miles apart; Hampton is about five miles above Teddington Weir and about 25 miles above London Bridge, and Sunbury is about 10 miles below Staines, following the course of the river. As regard the discharge of the River Thames at a point about midway between Sunbury and Hampton, reference may be made to Appendix D.

The Sunbury and Hampton samples were collected in mid-stream above the intakes of the East London‡ and Southwark and Vauxhall Water Companies respectively. The samples therefore were representative of water which, in the filtered condition, is supplied to the consumers in London.

The results are set forth in Tables 1 and 2, and Diagrams 1, 2, 3, and 4, and they may be considered together, as the biological quality of the water in the two cases was not widely dissimilar.

§B. coli test - Lactose-peptone milk test - Neutral red broth test -	A fair estimate would seem to be usually at least 10 (+ ·1 c.c.), but less than 100 (− ·01 c.c.) per c.c.
B. enteritidis sporogenes test	A fair estimate would seem to be usually positive 10 c.c. but negative 1 c.c. (1 spore in 10 c.c.)

It is obvious from the results that the River Thames at Sunbury and Hampton is polluted to a serious extent.

Whether or not a water containing 10 to 100 B. coli per c.c. is, even after careful filtration, fit for domestic use, involves the consideration of problems of great complexity. It is not desirable in a report of this kind to discuss at length debatable matters. Nevertheless, I would wish to be allowed to state briefly my personal views on the subject. All that need be said is that :—

---

* Lactose 1%, peptone 2%; sodium carbonate 0·1%; milk 20%, tinted with litmus solution. A test tube 2 in. by $\frac{1}{2}$ in. in a 6 in. by $\frac{3}{4}$ in. test tube should be used.

† Some of the chief methods used in the Bacteriological Examination of Sewage and Effluents. Page 135. Royal Commission on Sewage Disposal. Second Report.

‡ The East London Waterworks Company, however, draws its supply also from the Lea and from the chalk.

§ Throughout the text and in the diagrams of Division I. of this Report the term "B. coli" is meant to include gas-forming coli-like microbes, not of necessity invariably completely typical of the B. coli of the human intestine

No one doubts that proper filtration of an impure water is a most valuable security against the spread of water-borne disease, but the question arises whether filtration is an absolute or merely a relative safeguard.

Health statistics are of relative not of absolute value. Even admitting their reassuring character in the case of London, instances have occurred where a single epidemic has altogether discredited statistics founded on the experience perhaps of more than one previous decade, statistics which merely proved past comparative immunity from epidemic diseases, but possessing, as it turned out, actually no prospective value.

The hypothesis that there may be danger to the casual consumer, although the habitual consumers of a polluted water have become immunised and escape disease, may seem unduly fanciful ; but is not altogether inconceivable.

There is danger in assuming that what holds good, or appears to hold good, in one case applies to other cases of seemingly parallel sort. There is hazard in deducing from the particular case of the alleged healthiness of London and its comparative immunity from enteric fever, that 10 to 100 B. coli per c.c. in a drinking-water stream involves no element of risk, provided the water is filtered before consumption. It is impossible to say how far the immense scale of the operations of the London Water Companies conceal minor mischief due to London water. It is conceivable that a poison may be present in a water in appreciable amount and yet be so generally and equally spread among the consumers of the water that, although the total amount present is not necessarily small, the fractional dose to each consumer is so minute that it seldom succeeds in overcoming the natural resistance of the individual. Disease produced here and there casually, in this way would be apt to escape the vigilance of the sanitarian ; or, if its existence were suspected, its true origin would necessarily be extremely difficult to trace. Moreover, enteric fever is not the only disease capable of being water-borne.

Apart from death or definable disease there is an " under par " condition too often observed among the inhabitants of London, which conceivably may be associated, although possibly to a minor, or even to a negligible, extent with a water supply, in part, of questionable purity.

It needs to be remembered that enteric fever is classed as a preventible disease. Hence a single case arising from water supply is in a sense a blot on sanitary progress, and is one of the units which together go to foster in our midst the morbific virus of a disease which sanitarians hesitate to recognise as a necessary evil.

The towns bordering the Upper Thames are not now conspicuous as regards the endemic and epidemic prevalence of typhoid fever. Does precedent enable us to state that this condition will of necessity persist indefinitely? If not, might not this very circumstance alter the whole complexion of affairs, and convert a danger at present potential and remote into a standing menace to health.

However, this may be, the fact remains that in preventive medicine one tenet of our faith regards a pure water supply as of fundamental importance. The River Thames above the intakes of some of the London Water Companies is very impure, and the results of bacteriological examination indicate that the objectionable bacteria are greatly reduced in number, but are not always eliminated by the filtration process (*see* Section XI.).

It will be noted that the biological characters, as judged by the tests employed, of the *strains* of B. coli isolated from the samples of water examined were rarely other than typical of B. coli as freshly isolated from human fæces.

Thus, considering the results together, 24 out of 34 coli-like microbes isolated in pure culture from the samples in question reacted positively in all respects to the tests employed. Four (otherwise typical) gave no indol reaction, three (otherwise typical) gave no clot in milk culture ; only three failed both as regards indol and clot.

The characters and the number of these coli-like microbes suggest that the River Thames at Sunbury and Hampton is extremely dilute sewage; that is, sewage diluted, about 1,000 to 10,000 times.

TABLE 1.

Showing the Results of the Bacteriological Examination of Thames Water at Sunbury. Samples collected in Midstream above the intake of the East London Water Company.

TABLE 2.

Showing the Results of the Bacteriological Examination of Thames Water at Hampton. Samples collected in Midstream above the Intake of the Southwark and Vauxhall Water Companies.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 1 showing the Results of the Bacteriological Examination of Thames Water at Sunbury.

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,00
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·0000 c.c.
1	—	4	2	1903.	Thames water at Sunbury			+			
2	1.50 p.m.	5	2	,,	- ditto - ditto - -		+	–			
3	11.30 a.m.	6	2	,,	- ditto - ditto -				+	–	
4	10.50 a.m.	7	2	,,	- ditto - ditto - -			+	–		
5	1.50 p.m.	9	2	,,	- ditto - ditto - -		+	–			
6	10.50 a.m.	10	2	,,	- ditto - ditto - -		+	–			
7	12.30 p.m.	11	2	,,	- ditto - ditto - -		+	–			
8	12.55 p.m.	12	2	,,	- ditto - ditto - -		+	–			
9	12.30 p.m.	13	2	,,	- ditto - ditto - -		+	–			
10	10.45 a.m	14	2	,,	- ditto - ditto - -			+	–		
11	1.30 p.m.	16	2	,,	- ditto - ditto - -		+	–			
12	11.55 a.m.	17	2	,,	- ditto - ditto - -		+	–			
13	1.45 p.m.	18	2	,,	- ditto - ditto - -	-	-	-	No record	- -	-
14	1.50 p.m.	19	2	,,	- ditto - ditto - -			+	–		
15	12.40 p.m.	23	2	,,	- ditto . ditto - -		+	–			
16	12.50 p.m.	2	3	,,	- ditto - ditto - -		+	–			
17	12.50 p.m.	9	3	,,	- ditto - ditto - -		+	–			
18	1.45 p.m.	16	3	,,	- ditto - ditto - -		+	–			
					Average results.	**A fair estimate would seem to be at least 10 but less than 100 coli-like microbes per c.c.**					

aples Collected in Midstream above the intake of the East London Water Company.

3.				4.						5.						6.
ef Biological Characters of rain of B. Coli present in the mber specified in Col. 2.				B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence. L.P.M.=Lactose, Peptone, Milk test. + = Gas, acid and clot.						
ine e" es, rs C.)	Indol. (Broth cultures 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days, at 37° C.)		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	REMARKS.
		(a)	(b)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
	–	+	–	-	-	(Negative 10 c.c.)		-	-	-	-	-	No record	-	-	Samples 1, 4, 8, 13 and 16 contained 1,500, 1,600, 700, 570 and 3,100 microbes per c.c. respectively (agar at 37° C.).
	–	+	+	-	-	-	ditto	-	-			+	–	N.R.		
	–	+	–	+	–								+	–	L.P.M.	
	+	+	+	–	-	-	(Positive 10 c.c.)	-	-			+	–	N.R.		
	+	+	+	–	-	-	- ditto	-	-		+	–	L.P.M.			
	–	+	+		+	–						+	–	N.R.		
	+	+	+	–	-		(Positive 10 c.c.)		-		+	–	L.P.M.			
	+	+	+	+	–					-	-	-	No record.			
	+	+	+	–	-	(10 c.c. culture broken)			-	+	–	N.R.				
	+	+	–	–	-		(Positive 10 c.c.)		-			+	–	L.P.M.		
	+	+	+	+	–						+	–	N.R.			
	+	+	+	+	–						+	–	L.P.M.			
-	No record	-	-	-	-		No record	-	-	-	-	-	No record.			
	–	+	+	–	-		(Positive 10 c.c.)		-		+	–	N.R.			
	+	+	+	–	-	-	- ditto	-	-		+	–	L.P.M.			
	+	+	+	+	–					-	-	-	No record.			
	+	+	+	+	–						+	–	L.P.M.			
	+	+	+	–	-		(Positive 10 c.c.)		-			+	–	N.R.		

17 positive in all respects.
no indol re-action.
no clot in milk culture.
both as regards indol and
.

A fair estimate would seem to be positive 10 c.c. but negative 1 c.c.

Both tests considered together a fair estimate would seem to be at least 10 but less than 100.

Division 1.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 2 showing the Results of the Bacteriological Examination of Thames Water at Hampton.

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1	—	4	2	1903	Thames water at Hampton -				+	–	
2	12.50 p.m.	5	2	,,	- ditto - ditto - -			+	–		
3	12.50 p.m.	6	2	,,	- ditto - ditto - -		+	–			
4	9.55 a.m.	7	2	,,	- ditto - ditto - -			+	–		
5	12.50 p.m.	9	2	,,	- ditto - ditto - -		+	–			
6	11.50 a.m.	10	2	,,	- ditto - ditto - -		+	–			
7	1.30 p.m.	11	2	,,	- ditto - ditto - -		+	–			
8	11.50 a.m.	12	2	,,	- ditto - ditto - -	+	–				
9	1.20 p.m.	13	2	,,	- ditto - ditto - -		+	–			
10	9.50 a.m.	14	2	,,	- ditto - ditto - -		+	–			
11	2.10 p.m.	16	2	,,	- ditto - ditto - -		+	–			
12	12.50 p.m.	17	2	,,	- ditto - ditto - -	+	–				
13	12.50 p.m.	18	2	,,	- ditto - ditto - -	- - - No record - - -					
14	12.50 p.m.	19	2	,,	- ditto - ditto - -			+	–		
15	1.20 p.m.	23	2	,,	- ditto - ditto - -		+	–			
16	1.35 p.m.	2	3	,,	- ditto - ditto - -		+	–			
17	1.50 p.m.	9	3	,,	- ditto - ditto - -		+	–			
18	12.50 p.m.	16	3	,,	- ditto - ditto - -		+	–			
					Average results.	A fair estimate would seem to be at least 10 but less than 100 coli-like microbes per c.c.					

Samples Collected in Midstream above the intake of the Southwark and Vauxhall Water Company.

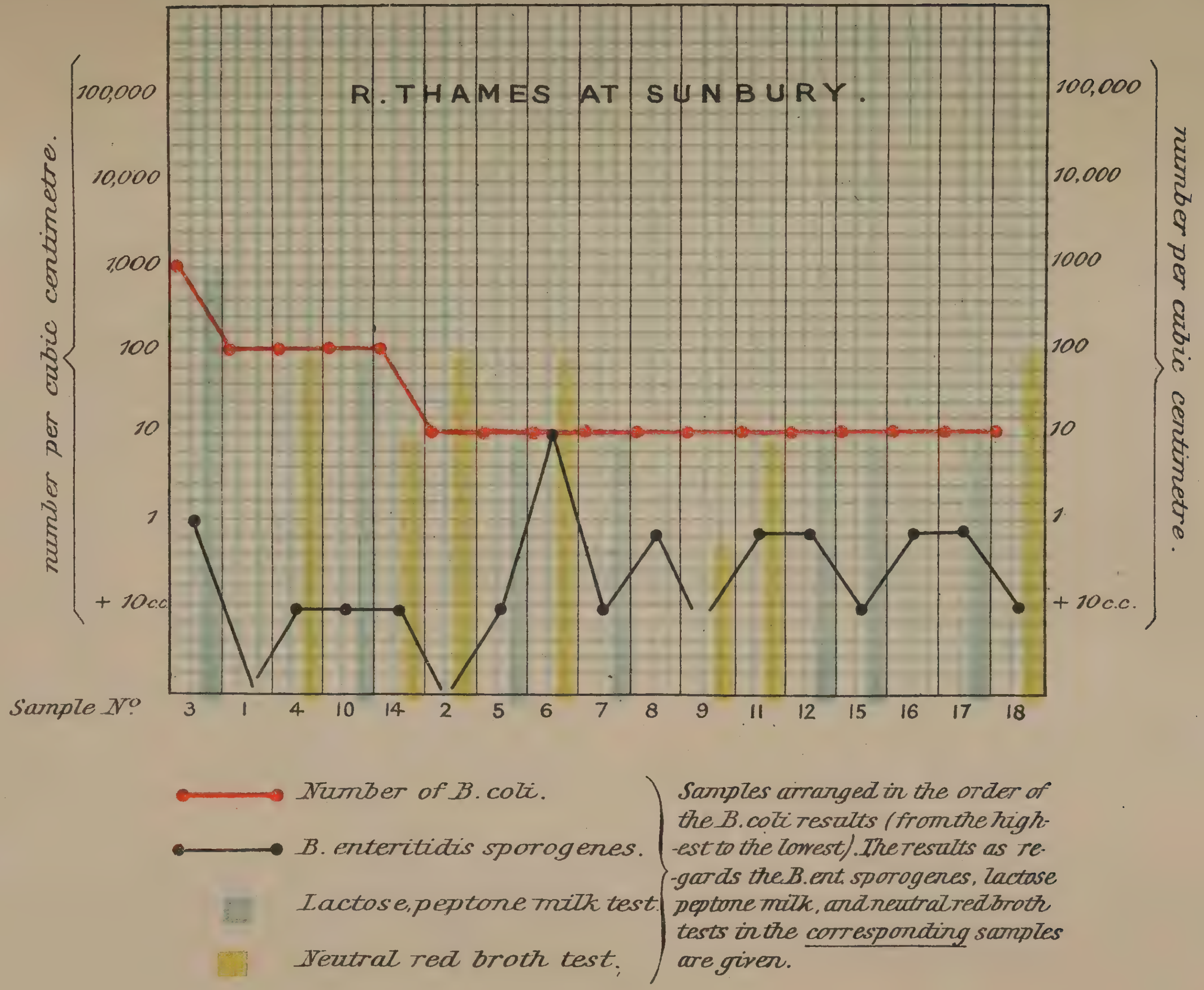
3.				4.						5.						6.
Chief Biological Characters of he strain of B. Coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes. (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence. L.P.M. = Lactose, Peptone, Milk test. + = Gas, acid and clot.						**REMARKS.**
Gas. Gelatine "shake" ultures, 4 hours 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	
		(a)	(b)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+	–	+	–	+	–								No record			Samples 1, 4, 8, 13 and 16 contained 1,000, 560, 300, 300 and 2,500 microbes per c.c. respectively (agar at 37° C.).
+	+	+	+	+	–						+	–	N.R.			
+	+	+	+	–	(Positive 10 c.c.)						+	–	L.P.M.			
+	+	+	+	–	ditto						+	–	N.R.			
+	+	+	+	+	–						+	–	L.P.M.			
+	+	+	+	+	–						+	–	N.R.			
+	+	+	+	–	(Positive 10 c.c.)						+	–	L.P.M.			
+	+	+	+	–	ditto								No record.			
+	+	+	+	–	ditto						+	–	N.R.			
+	+	+	+	–	ditto						+	–	L.P.M.			
+	+	+	+	–	ditto							+	–	N.R.		
+	+	+	+	–	ditto					+	–	L.P.M.				
No record						No record							No record.			
+	+	+	+	–	(Positive 10 c.c.)							+	–	N.R.		
+	–	+	+	+	–						+	–	L.P.M.			
+	+	+	–	+	–								No record.			
+	+	+	+	+	–						+	–	L.P.M.			
+	+	+	–	–	(Positive 10 c.c.)						+	–	N.R.			

3 out of 17 positive in all re-
cts.
gave no indol reaction.
gave no clot in milk culture.
failed both as regards indol
clot.

A fair estimate would seem to be positive 10 c.c., negative 1 c.c.

Both tests considered together a fair estimate would seem to be at least 10 but less than 100.

Diagram 7 showing the results of the Bacteriological Examination of the R. Thames at Sunbury.



Samples arranged in the order of the B. coli results (from the highest to the lowest). The results as regards the B. ent. sporogenes, lactose peptone milk, and neutral red broth tests in the corresponding samples are given.

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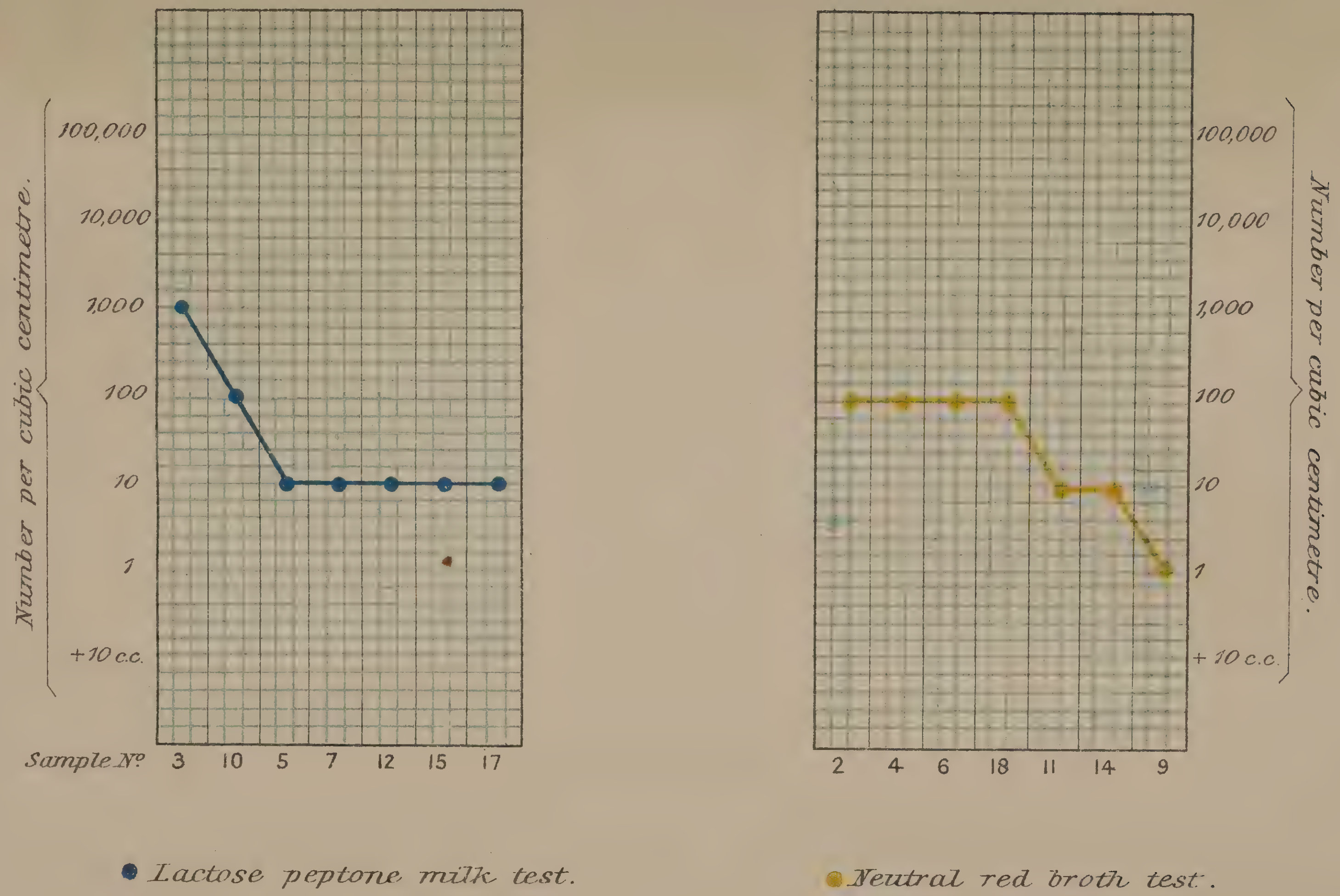
Diagram 2 showing the results of the Bacteriological Examination of the R. Thames at Sunbury.



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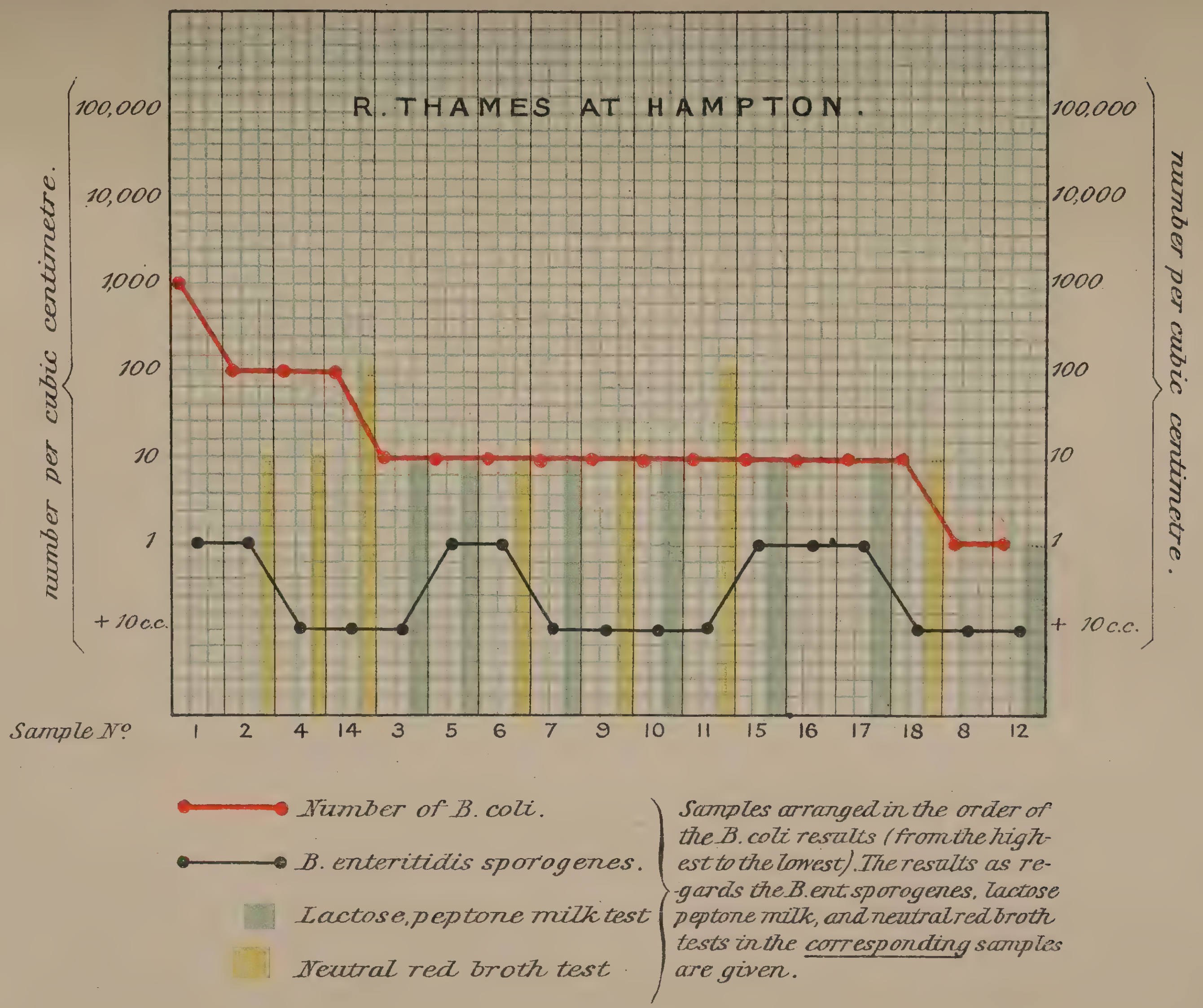
Examination of the R. Thames at Hampton.



Samples arranged in the order of the B. coli results (from the highest to the lowest). The results as regards the B. ent. sporogenes, lactose peptone milk, and neutral red broth tests in the corresponding samples are given.

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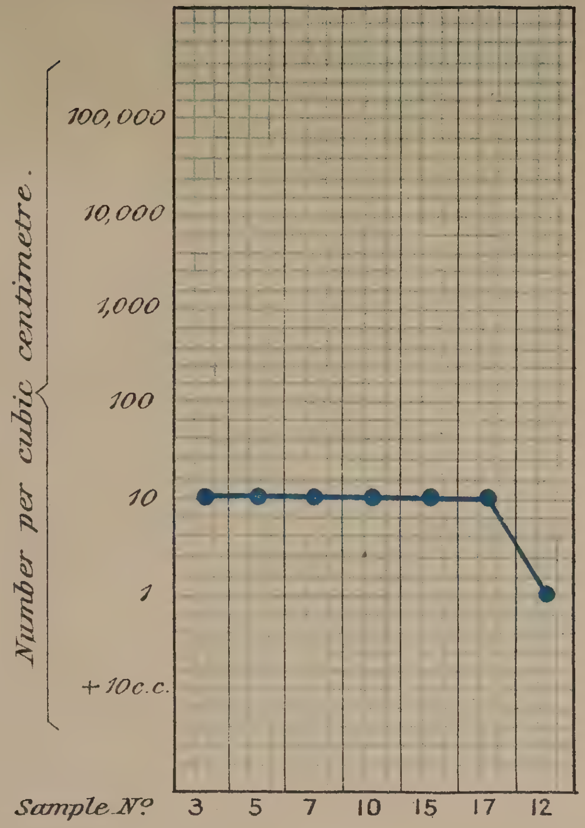
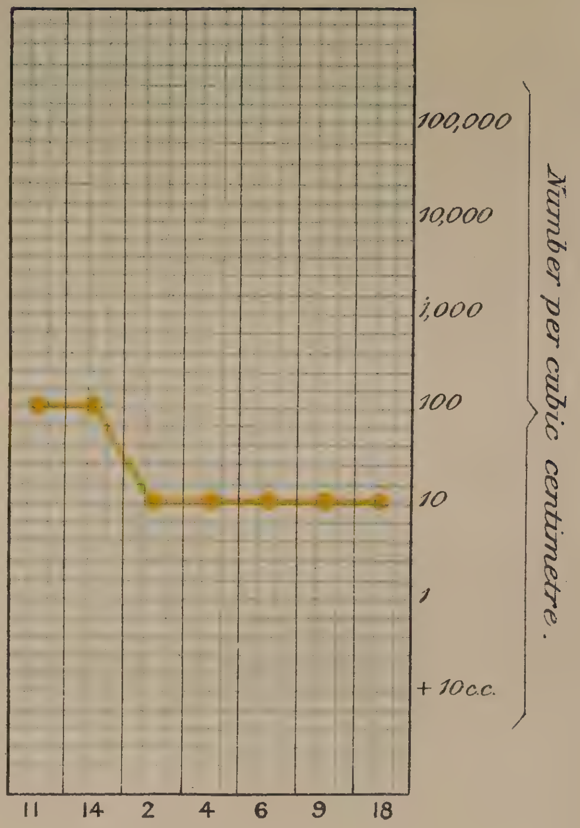
Examination of the R. Thames at Hampton.



● Lactose peptone milk test.



● Neutral red broth test

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Section II.—*The condition of the Barking (Northern outfall) and Crossness (Northern outfall) effluents.*

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

The unsatisfactory biological condition of the Barking and Crossness "chemically produced" effluents has long since been shown. It remains only to corroborate previous statements and inferences.

The results are shown in Table 3.

Briefly, the results may be summarised as follows:—

B. coli - - -	At least 100,000 per c.c.
B. enteritidis sporogenes	Between 100 to 1,000 spores per c.c.

It is obvious that the effluents, from the bacteriological point of view, are extremely foul.

The combined volume of effluent at Barking and Crossness during 1902 amounted to a daily average of 232 million gallons.

As regards the discharge of the Thames at high and low tide at a point about midway between Barking and Crossness, reference may be made to Appendix D.

As regards the character of the strains of B. coli isolated from the effluents, 12 out of 16 microbes reacted positively to the tests employed; two (otherwise typical) gave no indol reaction, two failed both as regards indol and clot.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 3 showing the results of the Bacteriological

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli. (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1		21	4	1903	BARKING CHEMICAL EFFLUENT -						+
2		30	4	,,	- ditto - - ditto - -						+
3		20	5	,,	- ditto - - ditto - -						+
4		21	5	,,	- ditto - - ditto - -						+
5		25	5	,,	- ditto - - ditto - -						+
6		26	5	,,	- ditto - - ditto - -						+
7		11	6	,,	- ditto - - ditto - -						+
8		12	6	,,	- ditto - - ditto - -						+
9		18	6	,,	- ditto - - ditto - -						+
10		19	6	,,	- ditto - - ditto - -						+
1		29	4	,,	CROSSNESS CHEMICAL EFFLUENT					+	−
2		6	5	,,	- ditto - - ditto - -						+
3		27	5	,,	- ditto - - ditto - -						+
4		11	6	,,	- ditto - - ditto - -						+
5		12	6	,,	- ditto - - ditto - -						+
6		18	6	,,	- ditto - - ditto - -						+
					Average results.	A fair estimate would seem to be at least 100,000 coli-like microbes per c.c.					

Examination of Crossness and Barking Chemical Effluents.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

3. Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				4. B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.					
Gas. (Gelatine "shake" cultures, 24 hrs. at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000
		(a)	(b)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
+	−	+	−			+	−		
+	+	+	+			+	−		
+	−	+	−			+	−		
+	+	+	+				+	−	
+	+	+	+			+	−		
+	+	+	+				+	−	
+	−	+	+			+	−		
+	+	+	+			+	−		
+	+	+	+			+	−		
+	+	+	+				+	−	
+	+	+	+			+	−		
+	+	+	+		+	−			
+	+	+	+				+	−	
+	+	+	+		+	−			
+	−	+	+				+	−	
+	+	+	+		+	−			

12 out of 16 positive in all respects.
2 gave no indol reaction.
2 failed both as regards indol and clot.

A fair estimate would seem to be between 100 and 1,000 spores of B. enteritidis sporogenes per c.c.

Section III.—*The biological qualities of the Barking (Northern outfall) and Crossness (Southern outfall) chemically precipitated sludge.*

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

The sludge is carried out by sludge steamers and deposited in Barrow Deep. The amount per week is 50,000 tons.

The results are shewn in Table 4.

Excluding sample 2′ the number of B. coli varied from 1,000,000 to 10,000,000,000 per c.c.

Excluding sample 2′ the number of spores of B. enteritidis sporogenes was extremely high and varied from 10,000 to 100,000 per c.c.

I am unable to explain the reason why sample 2′ yielded such apparently anomalous results.

The sludge, therefore, considered from the bacteriological point of view, is extremely foul.

The coli-like microbes isolated were in every case, with regard to the tests employed, indistinguishable from the typical B. coli of the human intestine.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 4 showing the Results of the Bacteriological

1. DESCRIPTION OF THE SAMPLE.						2.
No.	Time of Collection.				Other Details.	Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.
	Hour.	Day.	Month.	Year.		
1		21	4	1903	*Barking.*—Sample of *sludge* taken to sea by s.s. "Barrow" from Northern outfall.	Ten million
2		23	4	„	*Barking.*—Sample of *sludge* from Northern outfall.	One hundred million
3		30	4	„	*Barking.*—Sample of *sludge* from Northern outfall.	One thousand million
4		1	5	„	*Barking.*—Sample of *sludge* from Northern outfall.	One hundred million
1^{1}		29	4	„	*Crossness.*—Average sample of *sludge* sent to sea from Crossness per s.s. "Barking."	Ten thousand million
2^{1}		29	4	„	*Crossness.*—Average sample of *sludge* sent to sea from Crossness per s.s. "Belvedere."	*See* Remarks
3^{1}		6	5	„	*Crossness.*—Average sample of *sludge* sent to sea from Crossness per s.s. "Barking," a.m. tide.	Ten million
4^{1}		6	5	„	*Crossness.*—Average sample of *sludge* sent to sea from Crossness per s.s. "Barking," p.m. tide.	One million

Examination of Barking and Crossness Sludge.

3.				4.						5.
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						**REMARKS.**
Gas. (Gelatine "shake" cultures, 24 hrs. at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+	+	+	+					+	−	
+	+	+	+					+	−	
+	+	+	+						+	
+	+	+	+						+	
+	+	+	+						+	
- -	*See* Remarks	- -	-	- - -		*See* Remarks		- -	- -	This sample (Crossness sludge No. 2,) was very liquid and strongly alkaline. It yielded negative results as regards B. coli and B. enteritidis sporogenes. The sample was re-examined but with similar results. I am unable to explain this seemingly anomalous result.
+	+	+	+						+	
+	+	+	+					+	−	

Section IV.—*The condition of the River Thames at high and low tide at Barking, opposite the Northern outfall.*

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Following the course of the river, Barking is about 12 miles below London Bridge and about 2 miles above Crossness.

The results of the bacteriological examination of the River Thames at this point are shewn in Table 5 and Diagrams 5 and 6.

The results may be summarised briefly as follows :—

B. coli test - - - - Lactose-peptone milk test - Neutral-red broth test - -	A fair estimate would seem to be about 100 (+ ·01 c.c.) to 1.000 (+ ·001 c.c.) per c.c.
B. enteritidis sporogenes test	The results varied from 1 to 100 per c.c. At least 10 (+ ·1 c.c.) but less than 100 (− ·01 c.c.) would seem to be a fair estimate.

The river at this point might fitly be described as sewage diluted about 100 to 1,000 times.

The strains of B. coli isolated from the different samples were, as regards the tests applied, nearly always typical. Thus 22 out of 24 microbes were positive in all respects. The remaining two coli-like microbes failed as regards indol formation and clotting of milk.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

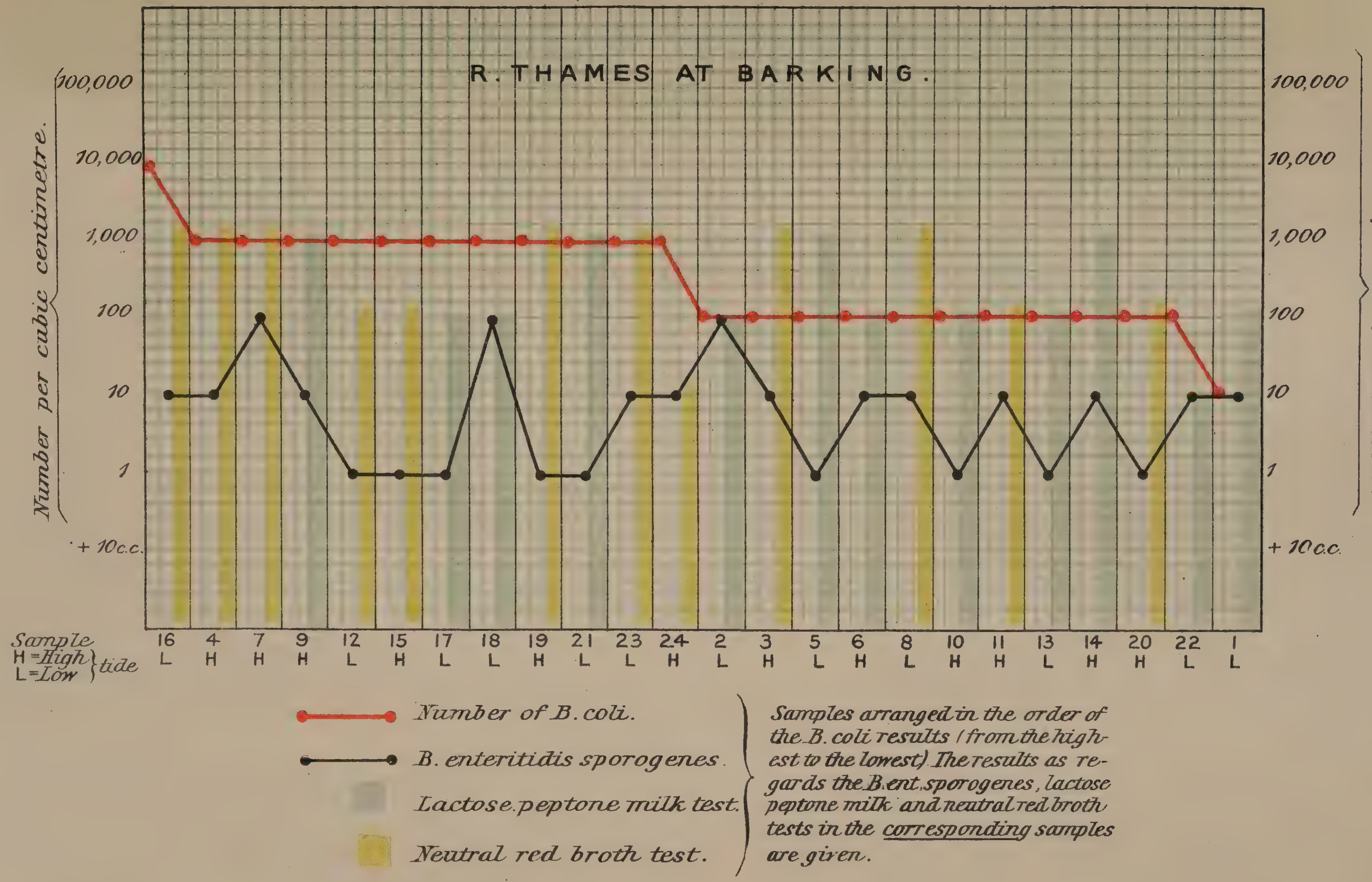
Table 5 showing the Results of the Bacteriological Examination of Thames Water at Barking.

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1		26	2	1903	Thames water at Barking - High tide.		+	−			
2		26	2	,,	Thames water at Barking - Low tide.			+	−		
3		4	3	,,	Thames water at Barking - High tide.			+	−		
4		4	3	,,	Thames water at Barking - Low tide.				+	−	
5		12	3	,,	Thames water at Barking - High tide.			+	−		
6		12	3	,,	Thames water at Barking - Low tide.			+	−		
7		19	3	,,	Thames water at Barking - High tide.				+	−	
8		19	3	,,	Thames water at Barking - Low tide.			+	−		
9		27	3	,,	Thames water at Barking - High tide				+	−	
10		27	3	,,	Thames water at Barking - Low tide.			+	−		
11		31	3	,,	Thames water at Barking - High tide.			+	−		
12		31	3	,,	Thames water at Barking - Low tide.				+	−	
13		17	4	,,	Thames water at Barking - High tide.			+	−		
14		17	4	,,	Thames water at Barking - Low tide.			+	−		
15		21	4	,,	Thames water at Barking - High water.				+	−	
16		21	4	,,	Thames water at Barking - Low water.					+	−
17		30	4	,,	Thames water at Barking - High tide.				+	−	
18		30	4	,,	Thames water at Barking - Low tide.				+	−	
19		5	5	,,	Thames water at Barking - High tide.				+	−	
20		5	5	,,	Thames water at Barking - Low tide.			+	−		
21		12	5	,,	Thames water at Barking - High tide.				+	−	
22		12	5	,,	Thames water at Barking - Low tide.			+	−		
23		19	5	,,	Thames water at Barking - High tide.				+	−	
24		19	5	,,	Thames water at Barking - Low tide.				+	−	
					Average results.	About 100 to 1,000 coli-like microbes per c.c. would seem to be a fair estimate.					

Samples Collected in Midstream at High and Low Tide opposite Northern Outfall Sewage Works.

3.				4.						5.						6.
Chief Biological Characters of he strain of B. Coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence. L.P.M. = Lactose, Peptone, Milk. + = Gas, acid and clot.						**Remarks.**
Gas. ielatine "shake" ultures, 4 hours t 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	
				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·0001 c.c.	
		(a)	(b)													
+	+	+	+		+	–						+	–	L.P.M.		
+	+	+	+			+	–					+	–	L.P.M.		
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+	+	–								+	–	L.P.M.	
+	–	+	–		+	–						+	–	L.P.M.		
+	+	+	+			+	–						+	–	N.R.	
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+		+	–							+	–	L.P.M.	
+	+	+	+	+	–							+	–	L.P.M.		
+	+	+	+		+	–						+	–	N.R.		
+	+	+	+	+	–							+	–	N.R.		
+	+	+	+	+	–							+	–	L.P.M.		
+	+	+	+		+	–							+	–	L.P.M	
+	+	+	+	+	–							+	–	N.R.		
+	+	+	+		+	–							+	–	N.R.	
+	–	+	–	+	–							+	–	L.P.M.		
+	+	+	+			+	–					+	–	L.P.M		
+	+	+	+	+	–								+	–	N.R.	
+	+	+	+	+	–							+	–	N.R.		
+	+	+	+	+	–								+	–	L.P.M.	
+	+	+	+		+	–					+	–	L.P.M.			
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+		+	–					+	–	N.R.			
22 out of 24 positive in all respects. 2 failed both as regards indol and clot.				The results varied from 1 to 100 per c.c. Probably a fair estimate would be at least 10 (+ ·1 c.c.), but less than 100 (– ·01 c.c.) per c.c.						Both tests considered together a fair estimate would seem to be about 100 (+ ·01 c.c.) to 1,000 (+ ·001 c.c.) per c.c.						

Diagram 5 showing the results of the Bacteriological
Examination of the R. Thames at Barking.



Samples arranged in the order of the B. coli results (from the highest to the lowest). The results as regards the B. ent. sporogenes, lactose peptone milk and neutral red broth tests in the corresponding samples are given.

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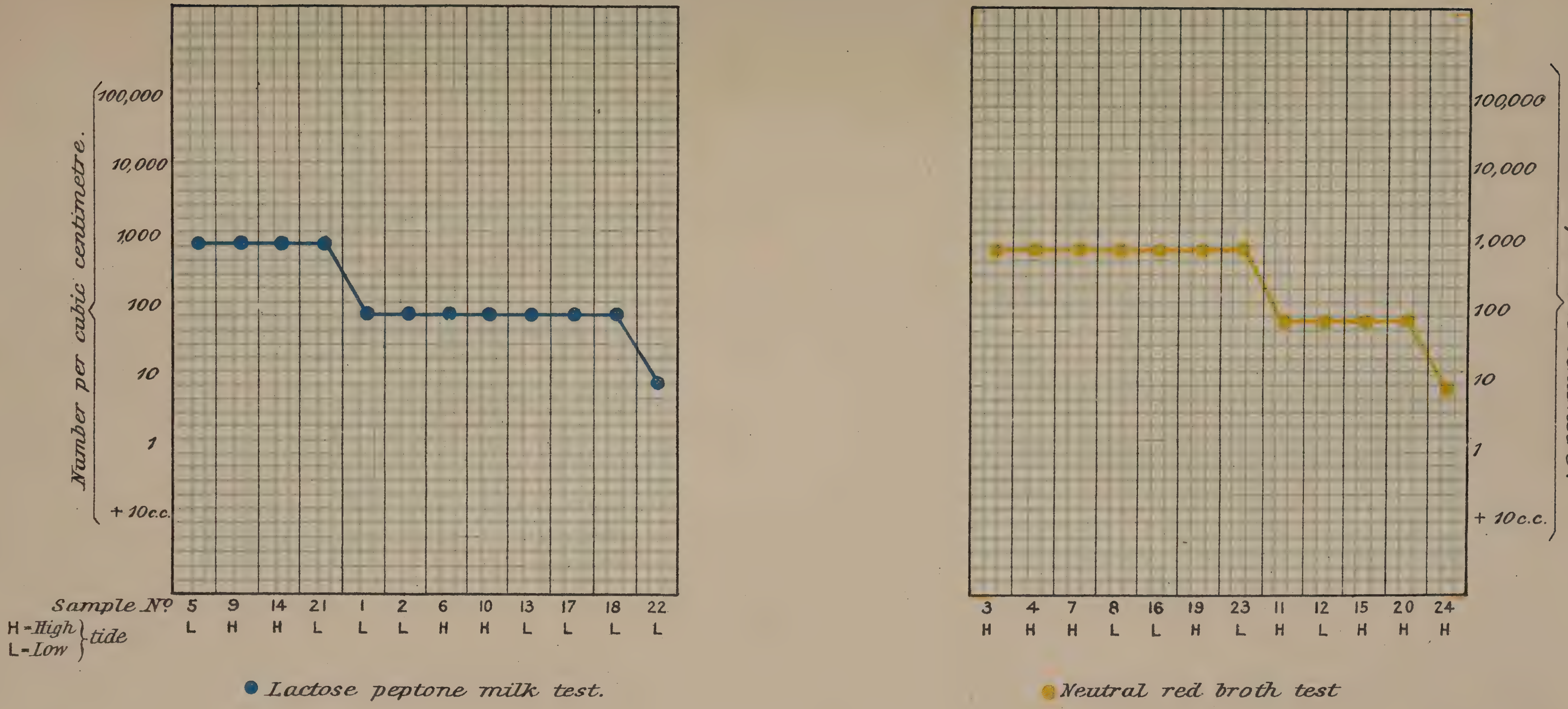
Diagram. 6 showing the results of the Bacteriological Examination of the R. Thames at Barking.



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Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Section V.—*The condition of the River Thames at high and low tide at Crossness, opposite the Southern outfall.*

Following the course of the river, Crossness is about two miles below Barking.

The results of the bacteriological examination of the River Thames at this point are shewn in Table 6 and Diagrams 7 and 8.

The results may be summarised briefly as follows :—

B. coli test - - - - Lactose-peptone milk test - Neutral red broth test - -	About 100 (+ ·01 c.c.) to 1,000 (+ ·001 c.c.), but more often 1,000 than 100 would seem to be a fair estimate.
B. enteritidis sporogenes test	At least 10 (+ ·1 c.c.) but less than 100 (− ·01 c.c.) per c.c. would appear to be a fair estimate.

The results were not dissimilar from those obtained at Barking, but on the whole were still less satisfactory.

The strains of B. coli isolated from the Crossness samples were, however, less typical than those isolated from the Barking samples. Eleven out of 18 microbes reacted positively as regards all the tests used, two (otherwise typical) gave no indol reaction, three (otherwise typical) gave no clot in milk culture, two failed both as regards indol and clot.

Division 1.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 6 showing the results of the Bacteriological Examination of Thames water at Crossness.

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1		24	2	1903	Thames water at Crossness - High tide.		+	–			
2		3	3	,,	Thames water at Crossness - High water.				+	–	
3		3	3	,,	Thames water at Crossness - Low tide.				+	–	
4		10	3	,,	Thames water at Crossness - High tide.			+	–		
5		10	3	,,	Thames water at Crossness - Low tide.				+	–	
6		17	3	,,	Thames water at Crossness - Low tide.				+	–	
7		24	3	,,	Thames water at Crossness - High tide.				+	–	
8		24	3	,,	Thames water at Crossness - Low tide.					+	
9		31	3	,,	Thames water at Crossness - High tide.			+	–		
10		31	3	,,	Thames water at Crossness - Low tide.				+	–	
11		21	4	,,	Thames water at Crossness - High tide.				+	–	
12		21	4	,,	Thames water at Crossness - Low tide.				+	–	
13		28	4	,,	Thames water at Crossness - High tide.		+	–			
14		28	4	,,	Thames water at Crossness - Low tide.			+	–		
15		5	4	,,	Thames water at Crossness - High tide.			+	–		
16		5	4	,,	Thames water at Crossness - Low tide.				+	–	
17		12	4	,,	Thames water at Crossness - High tide.			+	–		
18		12	4	,,	Thames water at Crossness - Low tide.					+	–
					Average results.	About 100 to 1,000 but more often 1,000 than 100 coli-like microbes per c.c. would seem to be a fair estimate.					

Samples collected in Midstream at High and Low Tide opposite Southern Outfall Sewage Works.

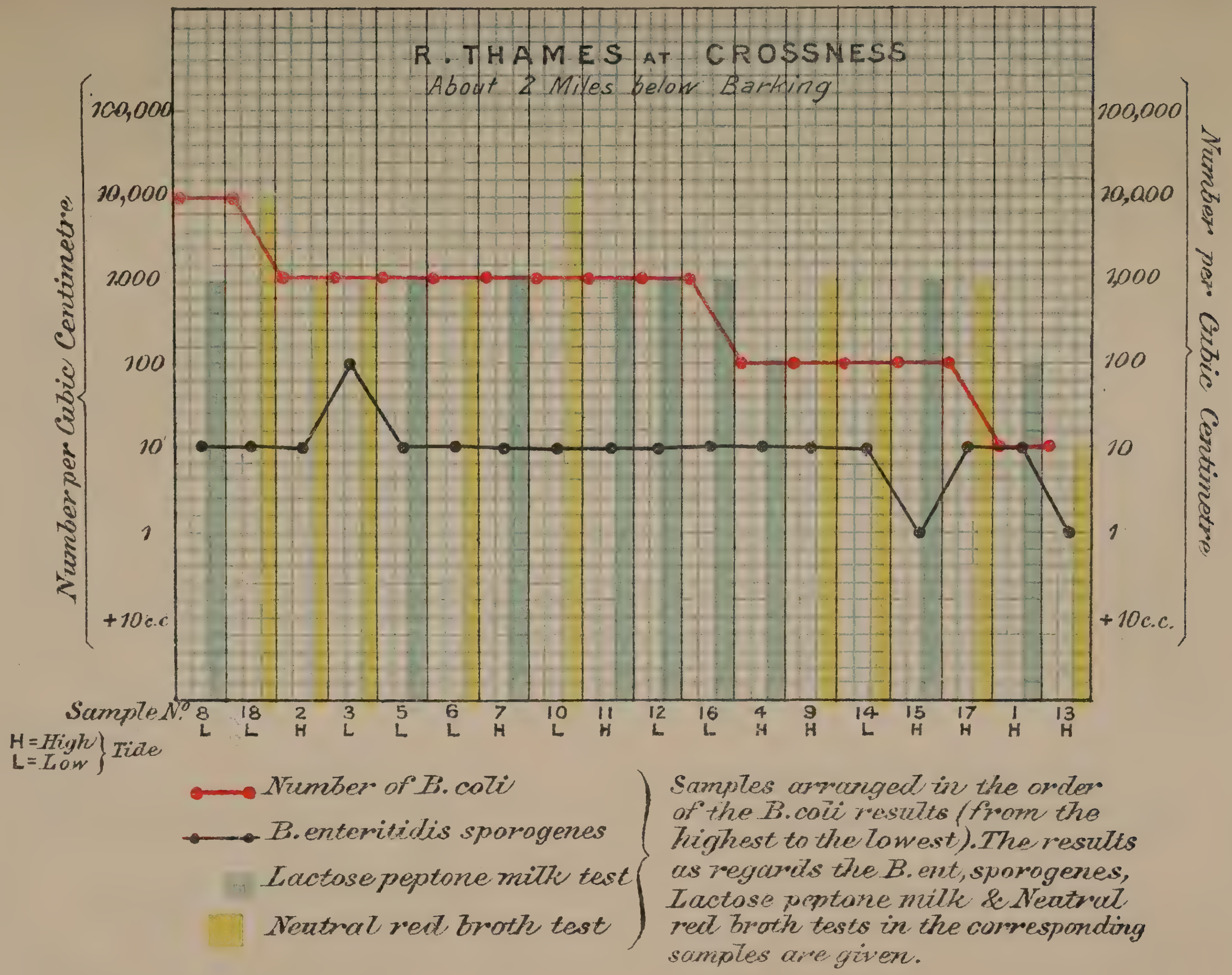
3.				4.						5.						6.
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				B. Enteritidis Sporongenes test. Number of spores of B. enteritidis sporogenes. (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence. L.P.M. = Lactose, Peptone, Milk test. + = Gas, acid and clot.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+	+	+	+		+	–						+	–		L.P.M.	
+	–	+	–		+	–							+	–	N.R.	
+	+	+	+			+	–						+	–	N.R.	
+	+	+	–		+	–						+	–	L.P.M.		
+	+	+	–		+	–							+	–	L.P.M.	
+	+	+	+		+	–							+	–	N.R.	
+	–	+	+		+	–							+	–	L.P.M.	
+	+	+	+		+	–							+	–	L.P.M.	
+	+	+	–		+	–							+	–	N.R.	
+	–	+	–		+	–								+	–	N.R.
+	+	+	+		+	–							+	–	L.P.M.	
+	–	+	+		+	–							+	–	L.P.M.	
+	+	+	+	+	–						+	–	N.R.			
+	+	+	+		+	–						+	–	N.R.		
+	+	+	+	+	–								+	–	L.P.M.	
+	+	+	+		+	–							+	–	L.P.M.	
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+		+	–								+	–	N.R.

1 out of 18 positive in all re-
cts.
gave no indol reaction.
gave no clot in milk culture.
failed both as regards indol and
.

At least 10 (+ ·1 c.c.) but less than 100 (– ·01 c.c.) per c.c. would seem to be a fair estimate.

Both tests considered together, a fair estimate would seem to be about 100 (+ ·01 c.c.) to 1,000 (+ ·001 c.c.), but more often 1,000 (+ ·001 c.c.) than 100 (+ ·01 c.c.) per c.c.

Examination of the R. Thames at Crossness.



Samples arranged in the order of the B. coli results (from the highest to the lowest). The results as regards the B. ent. sporogenes, Lactose peptone milk & Neutral red broth tests in the corresponding samples are given.

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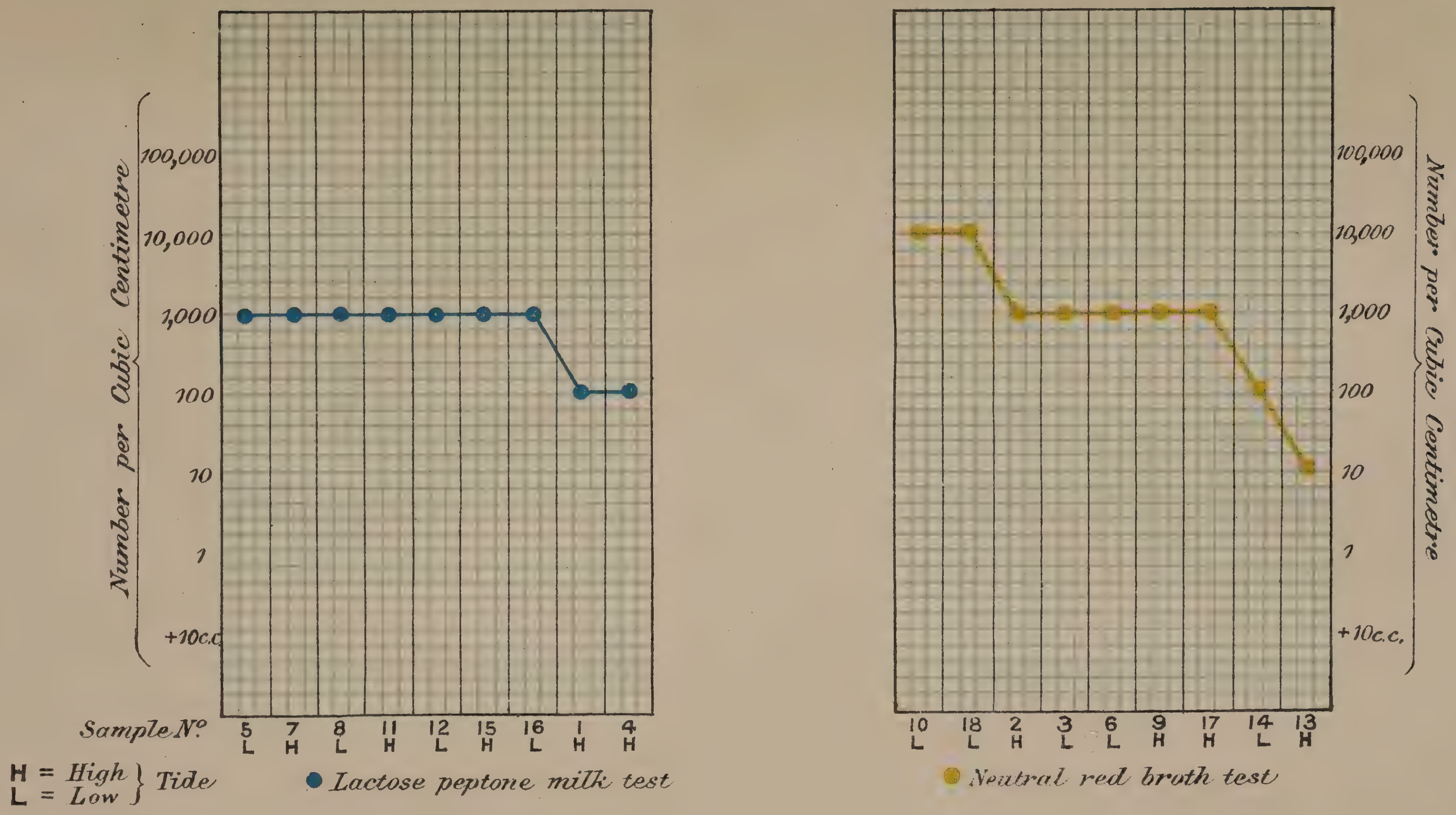
Diagram 8, showing the results of the
Bacteriological Examination of the R. Thames at Crossness



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Section VI.—*The condition of the River Thames at high and low tide at Purfleet.*

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Purfleet is about five miles below Crossness.

The results of the bacteriological examination of the River Thames at this point are shewn in Table 7 and Diagrams 9 and 10.

The results may be briefly summarised as follows :—

B. coli test - - - -	About 100 (+ ·01 c.c.) to 1,000 (+ ·001 c.c.) per c.c. is a fair average statement.
Lactose-peptone milk test -	
Neutral red broth test -	
B. enteritidis sporogenes test	Usually at least 10 (+ ·1 c.c.) but less than 100 (– ·01 c.c.).

Speaking in general terms the results were very similar to those obtained at Barking and Crossness. Certainly it could not be said that the river at Purfleet showed any definite signs of improvement from the bacteriological point of view.

As regards the coli-like microbes present in the samples of Purfleet water, 21 out of 32 microbes yielded positive results with all the tests employed. One (otherwise typical) gave no indol reaction, two (otherwise typical) gave no clot in milk culture, eight failed both as regards indol and clot.

Bacteriological Examination of the River Thames and Thames Estuary.

Table 7 showing the results of the Bacteriological

1. DESCRIPTION OF SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1		25	2	1903.	Thames water at Purfleet - Low tide.			+	–		
2		25	2	,,	Thames water at Purfleet - High water.		+	–			
3		4	3	,,	Thames water at Purfleet - Low water.					+	–
4		4	3	,,	Thames water at Purfleet - High water.				+	–	
5		11	3	,,	Thames water at Purfleet - Low water.				+	–	
6		11	3	,,	Thames water at Purfleet - High water.		+	–			
7		18	3	,,	Thames water at Purfleet - Low water.			+	–		
8		18	3	,,	Thames water at Purfleet - High water.		–				
9		25	3	,,	Thames water at Purfleet - Low tide.				+	-	
10		25	3	,,	Thames water at Purfleet - High tide.			+	–		
11		1	4	,,	Thames water at Purfleet - Low tide.			+	–		
12		1	4	,,	Thames water at Purfleet - High tide.		+	–			
13		15	4	,,	Thames water at Purfleet - Low tide.					+	
14		15	4	,,	Thames water at Purfleet - High tide.			+	–		
15		22	4	,,	Thames water at Purfleet - Low tide.				+	–	
16		22	4	,,	Thames water at Purfleet - High tide.			+	–		
17		29	4	,,	Thames water at Purfleet - High tide.			+	–		
18		6	5	,,	Thames water at Purfleet - Low tide.				+	–	
19		6	5	,,	Thames water at Purfleet - High tide.			+	–		
20		8	5	,,	Thames water at Purfleet - Low tide.					+	–
21		8	5	,,	Thames water at Purfleet - High tide.				+	–	
22		13	5	,,	Thames water at Purfleet - Low tide.					+	–
23		13	5	,,	Thames water at Purfleet - High tide.				+	–	
24		15	5	,,	Thames water at Purfleet - Low tide.				+	–	
25		20	5	,,	Thames water at Purfleet - High tide.				+	–	
26		20	5	,,	Thames water at Purfleet - Low tide.				+	–	
27		23	5	,,	Thames water at Purfleet - High tide.				+	–	
28		23	5	,,	Thames water at Purfleet - Low tide.				+	–	
29		27	5	,,	Thames water at Purfleet - High tide.			+	–		
30		27	5	,,	Thames water at Purfleet - Low tide.				+	–	
31		5	6	,,	Thames water at Purfleet - High tide.			+	–		
32		10	6	,,	Thames water at Purfleet - Low tide.					+	–
33		10	6	,,	Thames water at Purfleet - High tide.			+	–		
					Average results.	The number of coli-like microbes varied from 10 to 10,000 per c.c. About 100 to 1,000 but more often 1,000 than 100 is a fair estimate.					

xamination of Thames Water at Purfleet.

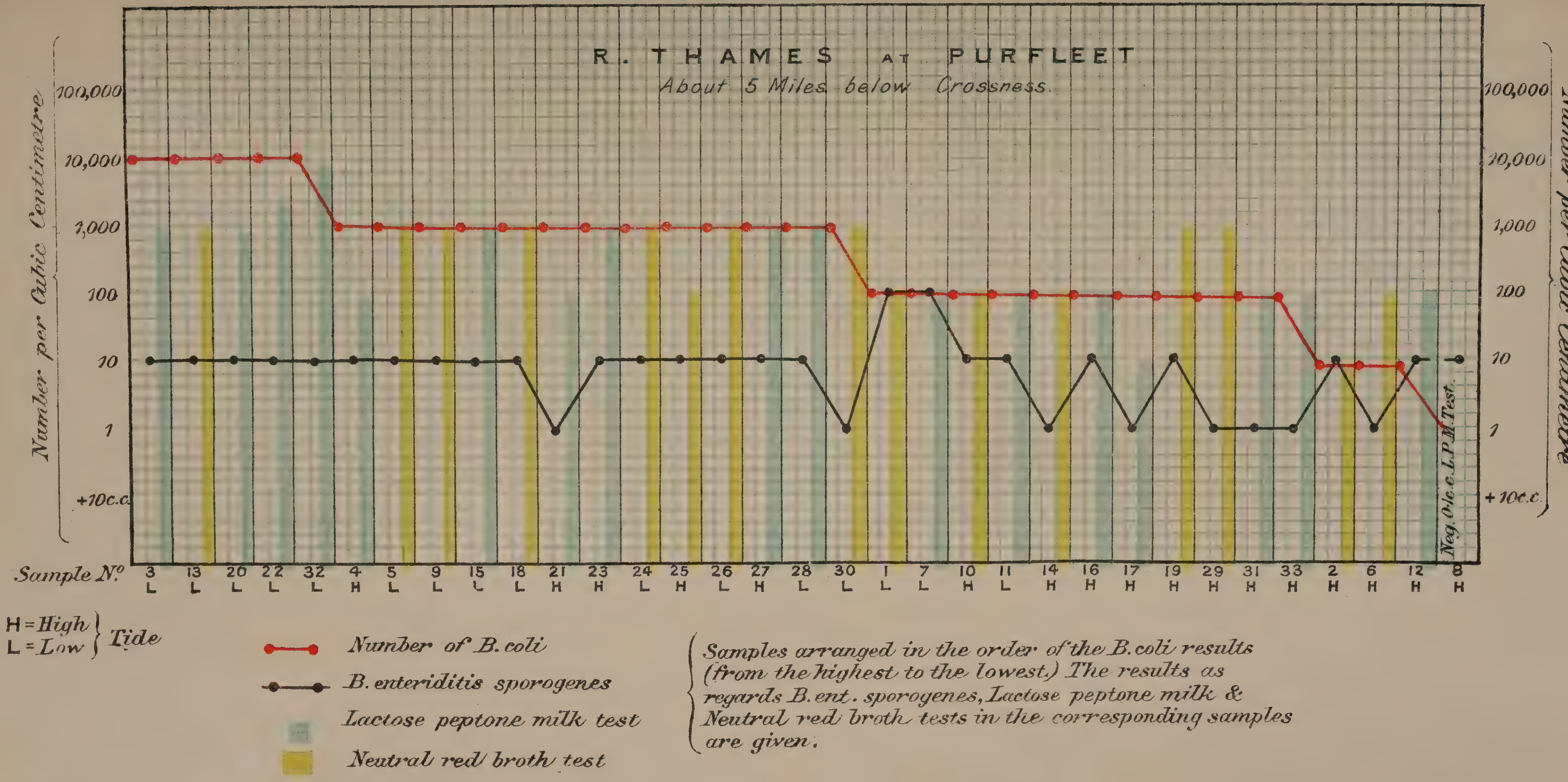
3. Chief Biological Characters of he strain of B. Coli present in the number specified in Col. 2.				4. B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anaerobic milk cultures). Cultures heated to 80° C. for 10 minutes.						5. N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence. L.P.M. = Lactose-Peptone Milk test. + = Gas, acid and clot.						6. REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.) (a)	(b)	1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	
				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+	+	+	+			+	–					+	–	N.R.		
+	+	+	+		+	–					+	–	N.R.			
+	+	+	+		+	–							+	–	L.P.M.	
+	–	+	–		+	–						+	–	L.P.M.		
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+	+	–							+	–	N.R.		
+	+	+	+			+	–					+	–	L.P.M.		
					+	–					–	L.P.M.				
+	+	+	+		+	–							+	–	N.R.	
+	–	+	–		+	–						+	–	N.R.		
+	+	+	+		+	–						+	–	L.P.M.		
+	+	+	+		+	–						+	–	L.P.M.		
+	–	+	–		+	–							+	–	N.R.	
+	+	+	–	+	–							+	–	N.R.		
+	–	+	+		+	–							+	–	L.P.M.	
+	+	+	+		+	–						+	–	L.P.M.		
+	+	+	+	+	–						+	–	L.P.M.			
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+		+	–							+	–	N.R.	
+	–	+	–		+	–							+	–	L.P.M.	
+	+	+	+	+	–							+	–	L.P.M.		
+	–	+	–		+	–							+	L.P.M.		
+	+	+	+		+	–							+	–	L.P.M.	
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+		+	–						+	–	N.R.		
+	+	+	+		+	–							+	–	N.R.	
+	–	+	–		+	–							+	–	L.P.M.	
+	+	+	+		+	–							+	–	L.P.M.	
+	+	+	+	+	–								+	–	N.R.	
+	+	+	+	+	–								+	–	N.R.	
+	+	+	–	+	–							+	–	L.P.M		
+	–	+	–		+	–								+	—	L.P.M.
+	–	+	–	+	–							+	–	L.P.M.		

21 out of 32 positive in all respects.
1 gave no indol reaction.
2 gave no clot in milk culture.
8 failed both as regards indol and clot.

The results varied from 1 to 100 per c.c. But a fair statement would be at least 10 (+ ·1 c.c.), but less than 100 (– ·01 c.c.).

Both tests considered together a fair statement would seem to be about 100 (+ ·01 c.c.) to 1,000 (+ ·001 c.c.), but more often 1,000 than 100.

Diagram C. showing the results of the Bacteriological Examination of the R. Thames at Purfleet.



Samples arranged in the order of the B. coli results (from the highest to the lowest.) The results as regards B. ent. sporogenes, Lactose peptone milk & Neutral red broth tests in the corresponding samples are given.

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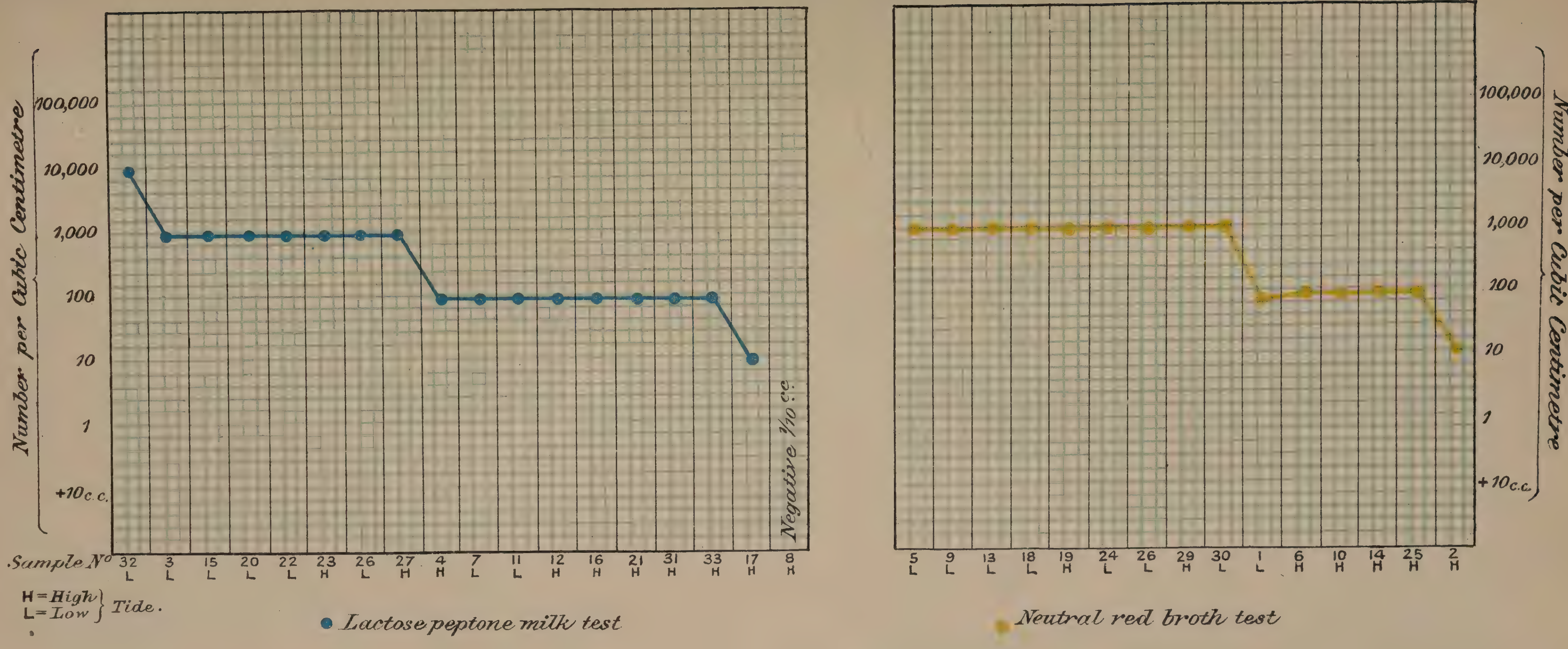
Diagram 10 showing the Results of the Bacteriological Examination of the R. Thames at Purfleet.



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Section VII.—*The condition of the River Thames at high and low tide at Grays.*

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Grays is about five miles below Purfleet.

The results of the bacteriological examination of the River Thames at Grays are shewn in Table 8 and Diagrams 11 and 12.

The results may be briefly summarised as follows :—

B. coli test - - - - Lactose-peptone milk test - Neutral red broth test - -	Varied usually from 10 (+ ·1 c.c.) to 100 (+ ·01 c.c.) to 1000 (+ ·001 c.c.) per c.c. Over 100 but less than 1000 is a fair average statement. The neutral red broth test gave, however, somewhat higher results.
B. enteritidis sporogenes test	Varied usually from 1 (+ 1 c.c.) to 10 (+ ·1 c.c.) per c.c., but more often 10 than 1.

The results were appreciably better than at Purfleet, although the river water even at Grays (10 miles below the Crossness outfall) is decidedly impure.

An analysis of the biological characters of the coli-like microbes shows that 24 out of 36 were positive in all respects. Five (otherwise typical) gave no indol reaction, five (otherwise typical) gave no clot in milk culture, and only two failed both as regards indol and clot.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 8.—Showing the Results of the Bacteriological

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1	Noon.	25	2	1903.	Thames water at Grays - - High tide.		+	–			
2	6 p.m.	25	2	,,	Thames water at Grays - - Low tide.		+	–			
3	4 a.m.	4	3	,,	Thames water at Grays - - High tide.		+	–			
4	5 a.m.	4	3	,,	Thames water at Grays - - Low tide.				+	–	
5	6 a.m.	11	3	,,	Thames water at Grays - - High tide.		+	–			
6	6 p.m.	11	3	,,	Thames water at Grays - - Low tide.				+	–	
7	4.30 p.m.	18	3	,,	Thames water at Grays - - High tide.		+	–			
8	10 a.m.	18	3	,,	Thames water at Grays - - Low tide.		+	–			
9	11 a.m.	28	3	,,	Thames water at Grays - - High tide.	+	–				
10	5.30 p.m.	28	3	,,	Thames water at Grays - - Low tide.			+	–		
11	–	1	4	,,	Thames water at Grays - - High tide.			+	–		
12	–	1	4	,,	Thames water at Grays - - Low tide.			+	–		
13	–	15	4	,,	Thames water at Grays - - High tide.			+	–		
14	–	15	4	,,	Thames water at Grays - - Low tide.			+	–		
15	–	22	4	,,	Thames water at Grays - - High tide.		+	–			
16	–	22	4	,,	Thames water at Grays - - Low tide.			+	–		
17	–	29	4	,,	Thames water at Grays - - High tide.		+	–			
18	–	29	4	,,	Thames water at Grays - - Low tide.			+	–		
19	–	6	5	,,	Thames water at Grays - - High tide.			+	–		
20	–	6	5	,,	Thames water at Grays - - Low tide.				+	–	
21	–	8	5	,,	Thames water at Grays - - Half flood.				+	–	
22	–	8	5	,,	Thames water at Grays - - Half ebb.				+	–	
23	–	13	5	,,	Thames water at Grays - - High tide.			+	–		
24	–	13	5	,,	Thames water at Grays - - Low tide.				+	–	
25	–	11	5	,,	Thames water at Grays. - - Half flood.			+	–		
26	–	14	5	,,	Thames water at Grays - - Half ebb.				+	–	
27	–	20	5	,,	Thames water at Grays - - High tide.			+	–		
28	–	20	5	,,	Thames water at Grays - - Low tide.			+	–		
29	–	21	5	,,	Thames water at Grays - - Half flood.				+	–	
30	–	21	5	,,	Thames water at Grays - - Half ebb.				+	–	
31	–	27	5	,,	Thames water at Grays - - High tide.			+	–		
32	–	27	5	,,	Thames water at Grays - - Low tide.				+	–	
33	–	3	6	,,	Thames water at Grays - - High tide.			+	–		
34	–	3	6	,,	Thames water at Grays - - Low tide.				+	–	
35	–	10	6	,,	Thames water at Grays - - Half flood.			+	–		
36	–	10	6	,,	Thames water at Grays - - Half ebb.				+	–	
					Average result - -	Varied usually from 10 (+ ·1 c.c., to 100 (+ ·01 c.c.) or 1,000 (+ ·001 c.c.) per c.c. over 100 but less than 1,000 coli-like microbes per c.c. is a fair average statement.					

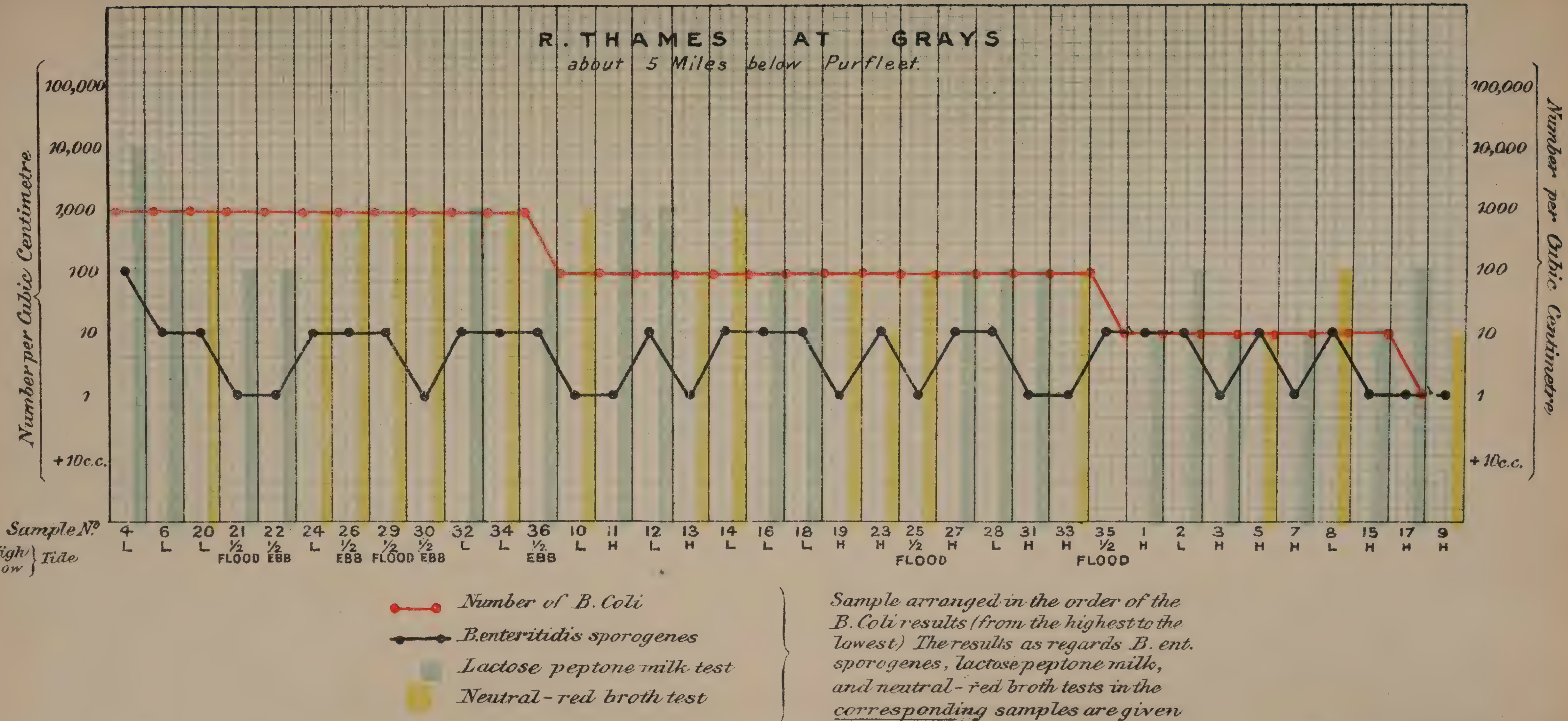
xamination of Thames Water at Grays.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

3. Chief Biological Character of ne strain of B. Coli present in the number specified in Col. 2.				4. B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk culture). Cultures heated to 80° C. for 10 minutes.						5. N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence, 48 hours at 37° C. L.P.M. = Lactose-Peptone milk tests. + = Gas, acid, and clot.						**Remarks.**
Gas. elatine shake" ultures, 4 hours 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk culture, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	
		(a)	(b)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+	–	+	–		+	–					+	–	L.P.M.			
+	+	+	+		+	–						+	–	L.P.M.		
+	+	+	+	+	–						+	–	L.P.M.			
+	+	+	+			+	–							+	–L.P.M.	
+	–	+	+		+	–					+	–	N.R.			
+	+	+	+		+	–							+	–	L.P.M.	
+	+	+	+	+	–						+	–	L.P.M.			
+	+	+	+		+	–						+	–	N.R.		
+	+	+	+	+	–						+	–	N.R.			
+	–	+	+	+	–								+	–	N.R.	
+	+	+	–	+	–								+	–	L.P.M.	
+	–	+	–		+	–							+	–	L.P.M.	
+	+	+	–	+	–							+	–	N.R.		
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+	+	–						+	–	L.P.M.			
+	+	+	–		+	–						+	–	L.P.M.		
+	+	+	+	+	–							+	–	L.P.M		
+	+	+	–		+	–						+	–	L.P.M.		
+	+	+	+	+	..							+	–	N.R.		
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+	+	–							+	–	L.P.M.		
+	+	+	+	+	–							+	–	L.P.M.		
+	+	+	+		+	–						–	N.R.			
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+	+	–							+	–	N.R.		
+	–	+	+		+	–							+	–	N.R.	
+	+	+	+		+	–						+	–	L.P.M.		
+	+	+	+		+	–						+	–	L.P.M.		
+	–	+	+		+	–							+	–	N.R.	
+	+	+	+	+	–								+	–	N.R.	
+	+	+	+	+	–							+	–	L.P.M.		
+	–	+	+		+	–							+	–	L.P.M.	
+	+	+	+	+	–								+	–	N.R.	
+	+	+	+		+	–							+	–	N.R.	
+	+	+	+		+	–						+	–	L P.M.		
+	+	+	–		+	–						+	–	L.P.M.		
24 out of 36 positive in all respects, 5 gave no indol reaction, 5 gave no clot in milk culture, 2 failed, both as regards indol and clot.				Varied usually from 1 (+1 c.c.) to 10 (+·1 c.c.); but more often 10 than 1 per c.c.						Both tests considered together a fair estimate would seem to be about 100 (+·01 c.c.) to 1000 (+·001 cc.).						

of the R. Thames at Grays.



Sample arranged in the order of the B. Coli results (from the highest to the lowest) The results as regards B. ent. sporogenes, lactose peptone milk, and neutral-red broth tests in the corresponding samples are given

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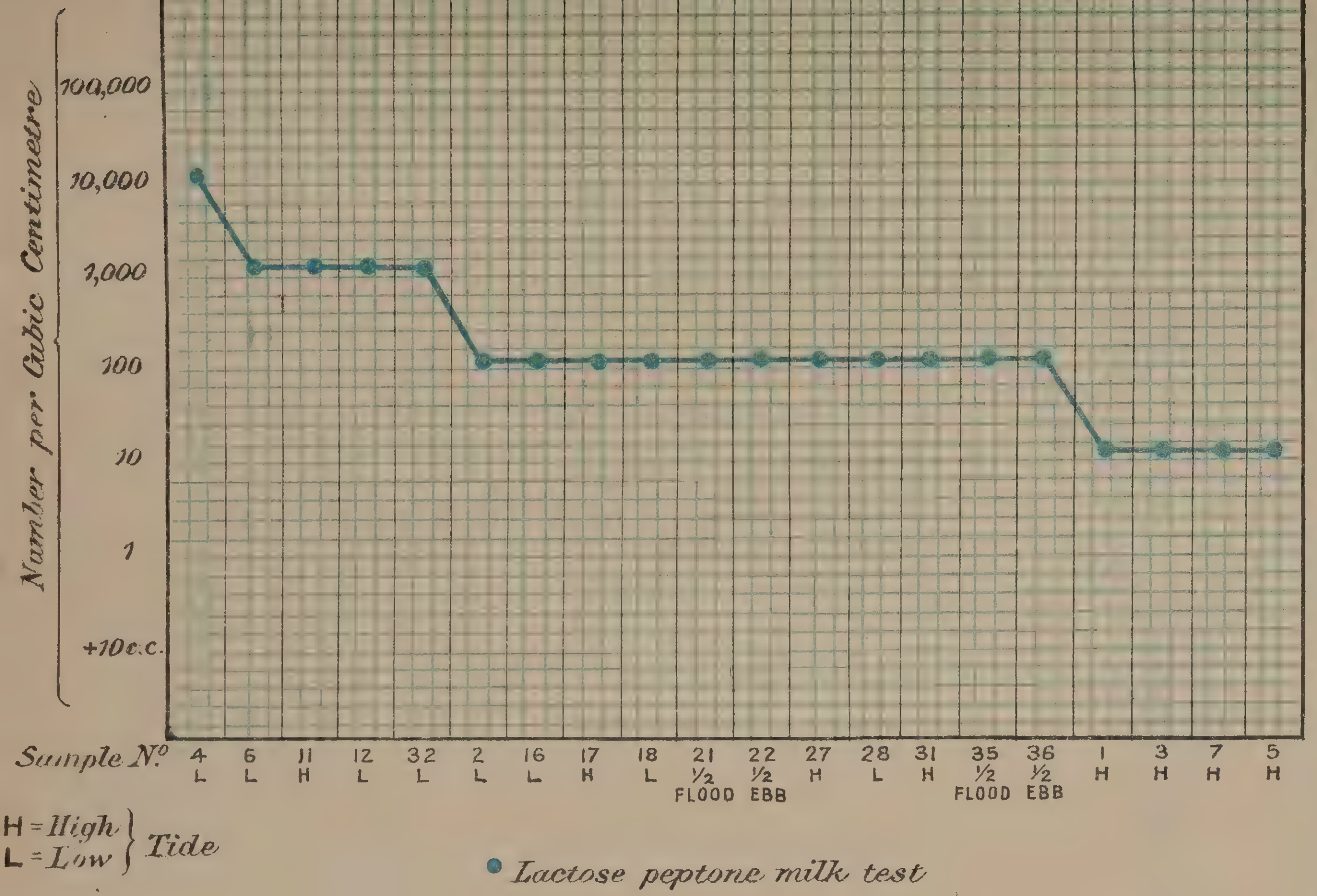
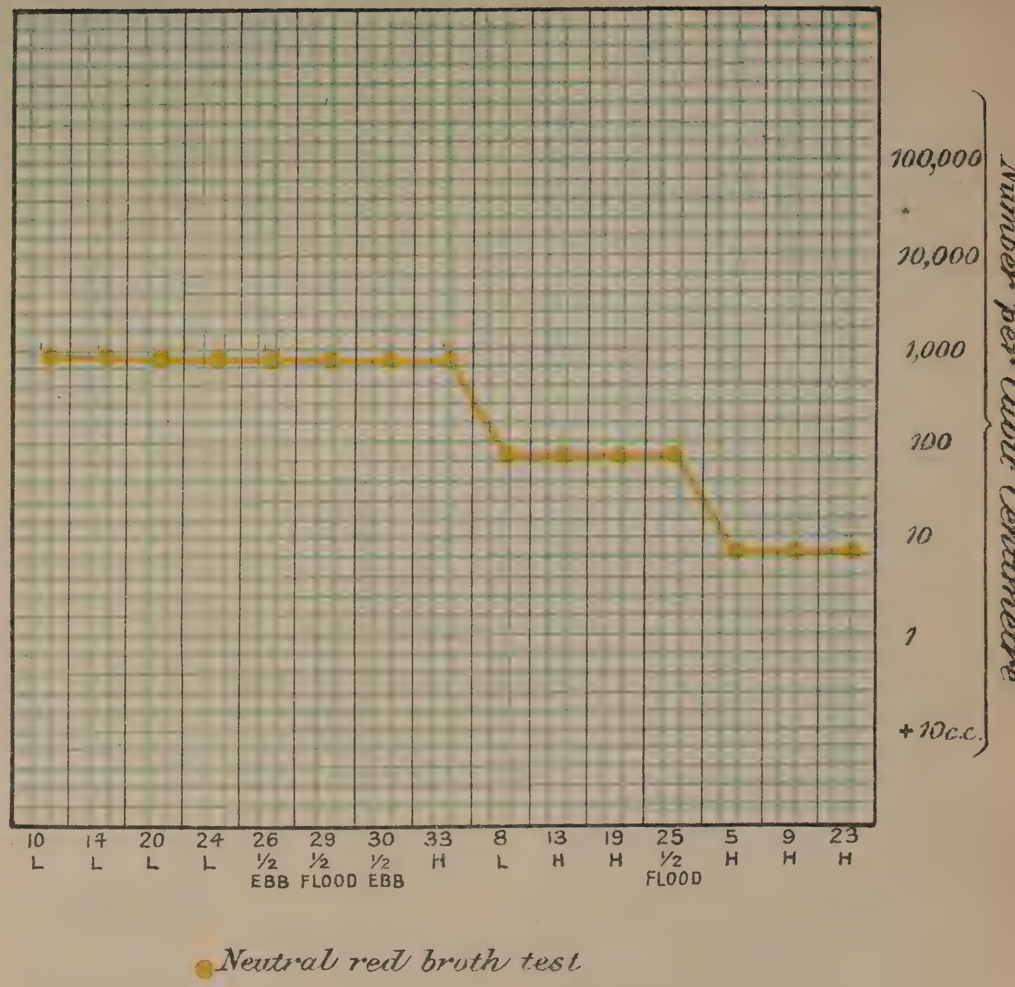
Examination of the R. Thames at Grays.





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Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Section VIII.—*The condition of the River Thames at high and low tide at Mucking.*

Mucking is about 10 miles below Grays.

The results of the bacteriological examination of the River Thames at Mucking are shewn in Table 9, and Diagrams 13 and 14.

The results may be briefly summarised as follows:—

B. coli test - - - - Lactose-peptone milk test - Neutral red broth test - -	Varied from 1 (+ 1 c.c.) to 10 (+ ·1 c.c.) to 100 (+ ·01 c.c) per c.c. About 10 (+ ·1 c.c.) would seem to be a fair estimate of the average number.
B. enteritidis sporogenes test	Varied from 1 (+ 1 c.c.) to 10 (+ ·1 c.c.), but much oftener 1 than 10 per c.c.

The results were decidedly better than at Grays, and indeed the bacteriological condition of the River Thames at Mucking was very similar to that found in the upper reaches of the river, namely, at Sunbury and Hampton. Except that at Mucking the spores of B. enteritidis sporogenes were more numerous, and the coli-like microbes less abundant than at Sunbury and Hampton.

Apart from the chemical constituents of the respective waters, the Thames water off Mucking lighthouse would seem, on the basis of the bacteriological results, as suitable for waterworks purposes, as in the neighbourhood of Sunbury and Hampton.

As regards the coli-like microbes, 16 out of 26 were positive in all respects. Two (otherwise typical) gave no indol reaction, two (otherwise typical) gave no clot in milk culture, six failed both as regards indol and clot.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 9 showing the Results of the Bacteriological

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection				Other Details.	1	10	100	1,000	10,000	100,00
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1		4	3	1903.	Thames water off Mucking Lighthouse. Low tide.		+	–			
2		4	3	„	Thames water off Mucking Lighthouse. High tide.		+	–			
3		11	3	„	Thames water off Mucking Lighthouse. Low tide.		+	–			
4		11	3	„	Thames water off Mucking Lighthouse. High tide.		+	–			
5		18	3	„	Thames water off Mucking Lighthouse. Low tide.	+	–				
6		18	3	„	Thames water off Mucking Lighthouse. High tide.	+	–				
7		25	3	„	Thames water off Mucking Lighthouse. Low tide.		+	–			
8		25	3	„	Thames water off Mucking Lighthouse. High tide.	+	–				
9		1	4	„	Thames water off Mucking Lighthouse. Low tide.		+	–			
10		1	3	„	Thames water off Mucking Lighthouse. High tide.	+	–				
11		29	3	„	Thames water off Mucking Lighthouse. Low tide.		+	–			
12		29	3	„	Thames water off Mucking Lighthouse. High tide.	+	–				
13		6	5	„	Thames water off Mucking Lighthouse. Low tide.		+	–			
14		6	3	„	Thames water off Mucking Lighthouse. High tide.		+	–			
15		13	3	„	Thames water off Mucking Lighthouse. Low tide.			+	–		
16		13	3	„	Thames water off Mucking Lighthouse. High tide.		+	–			
17		20	3	„	Thames water off Mucking Lighthouse. Low tide.		+	–			
18		20	3	„	Thames water off Mucking Lighthouse. High tide.	+	–				
19		27	3	„	Thames water off Mucking Lighthouse. Low tide.			+	–		
20		27	3	„	Thames water off Mucking Lighthouse. High tide.	+	–				
21		3	6	„	Thames water off Mucking Lighthouse. Low tide.			+	–		
22		3	6	„	Thames water off Mucking Lighthouse. High tide.		+	–			
23		10	6	„	Thames water off Mucking Lighthouse. Low tide.		+	–			
24		10	6	„	Thames water off Mucking Lighthouse. High tide.	+	–				
25		17	6	„	Thames water off Mucking Lighthouse. Low tide.		+	–			
26		17	6	„	Thames water off Mucking Lighthouse. High tide.		+	–			
					Average results.	About 10 (+ ·1) c.c. would seem to be a fair estimate of the average number.					

Examination of Thames Water off Mucking Lighthouse.

3.				4.						5.						6.
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence, 48 hours at 37° C. L.P.M. = Lactose, Peptone, Milk test. + = Acid, gas, and clot.						**Remarks.**
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days, at 37° C.)		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c	·0001 c.c.	.00001 c.c.	
+	+	+	+	+	–						+	–	L.P.M.			
+	+	+	+	+	–						+	–	L.P.M.			
+	+	+	+		+	–						+	–	N.R.		
+	–	+	–	+	–					+	–	N.R.				
+	+	+	+	+	–					+	–	L.P.M.				
+	–	+	–	+	–					+	–	L.P.M.				
+	+	+	+	+	–						+	N.R.				
+	–	+	–	+	–					+	–	N.R.				
+	+	+	+		+	–					+	L.P.M.				
+	+	+	–	+	–						+	L.P.M.				
+	+	+	+		+	–					+	–	N.R.			
+	+	+	+	+	–					+	–	N.R.				
+	+	+	+		+	–						+	N.R.			
+	+	+	+	+	–						+	–	L.P.M.			
+	–	+	–		+	–						+	L.P.M.			
+	+	+	+		+	–					+	–	L.P.M.			
+	+	+	–		+	–					+	–	N.R.			
+	+	+	+	+	–						+	–	N.R.			
+	–	+	–	+	–							+	–	L.P.M		
+	–	–	–	+	–					+	–	L.P.M.				
+	+	+	+	+	–							+	–	N.R.		
+	–	+	+	+	–					+	–	N.R.				
+	–	+	+	+	–						+	–	L.P.M.			
+	+	+	+	+	–					+	–	L.P.M.				
+	+	+	+		+	–					+	–	N.R.			
+	+	+	+	+	–						+	–	N.R.			

16 out of 26 positive in all espects.
2 gave no indol reaction.
2 gave no clot in milk culture.
6 failed both as regards indol nd clot.

Varied from 1 (+ 1 c.c.) to 10 (+ ·1 c.c.) but oftener 1 than 10 per c.c.

About 10 (+ ·1 c.c.) would seem to to be a fair estimate of the average number.

Diagram 13, Showing the results of the Bacteriological Examination of the R. Thames off Mucking Lighhouse.

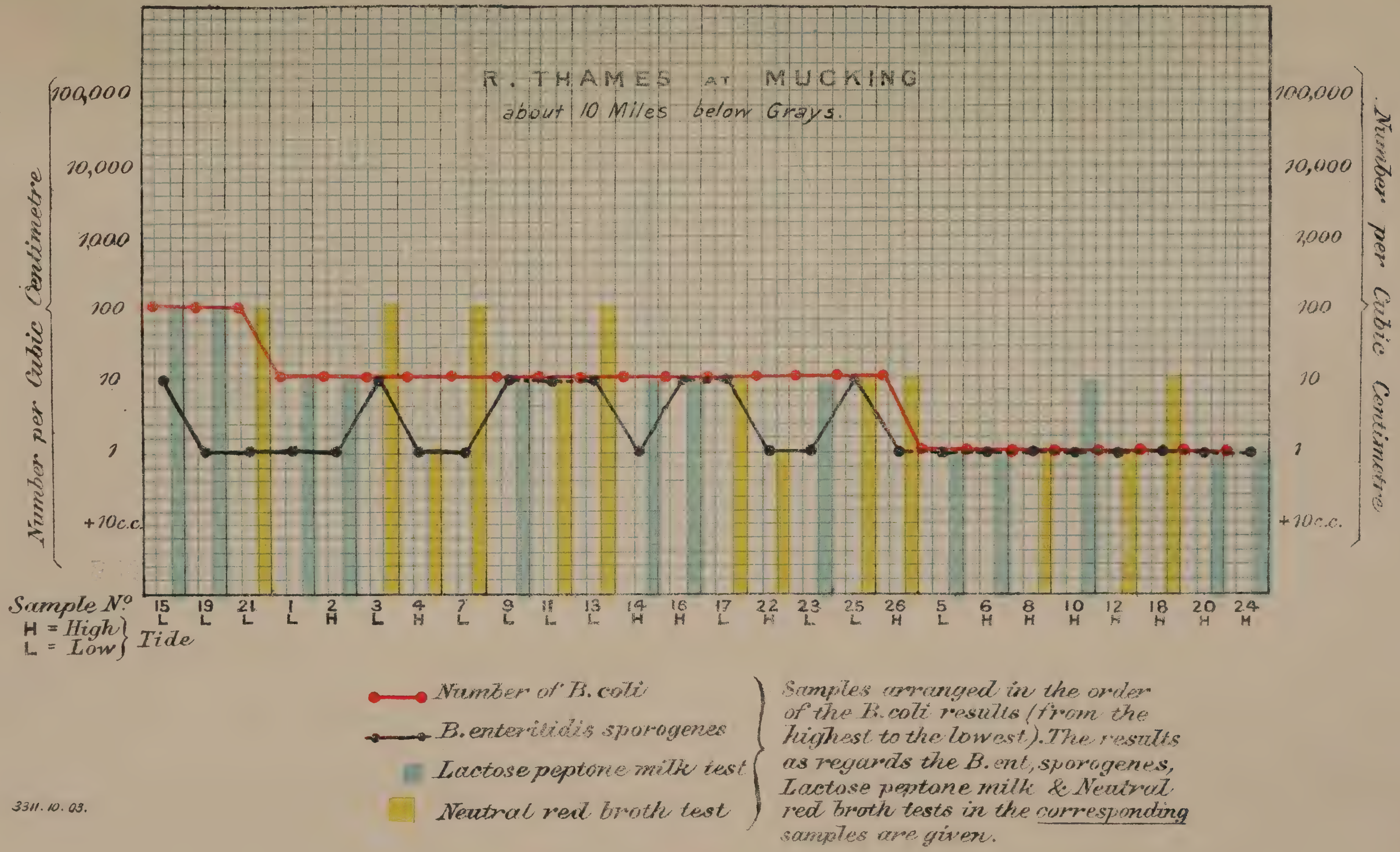

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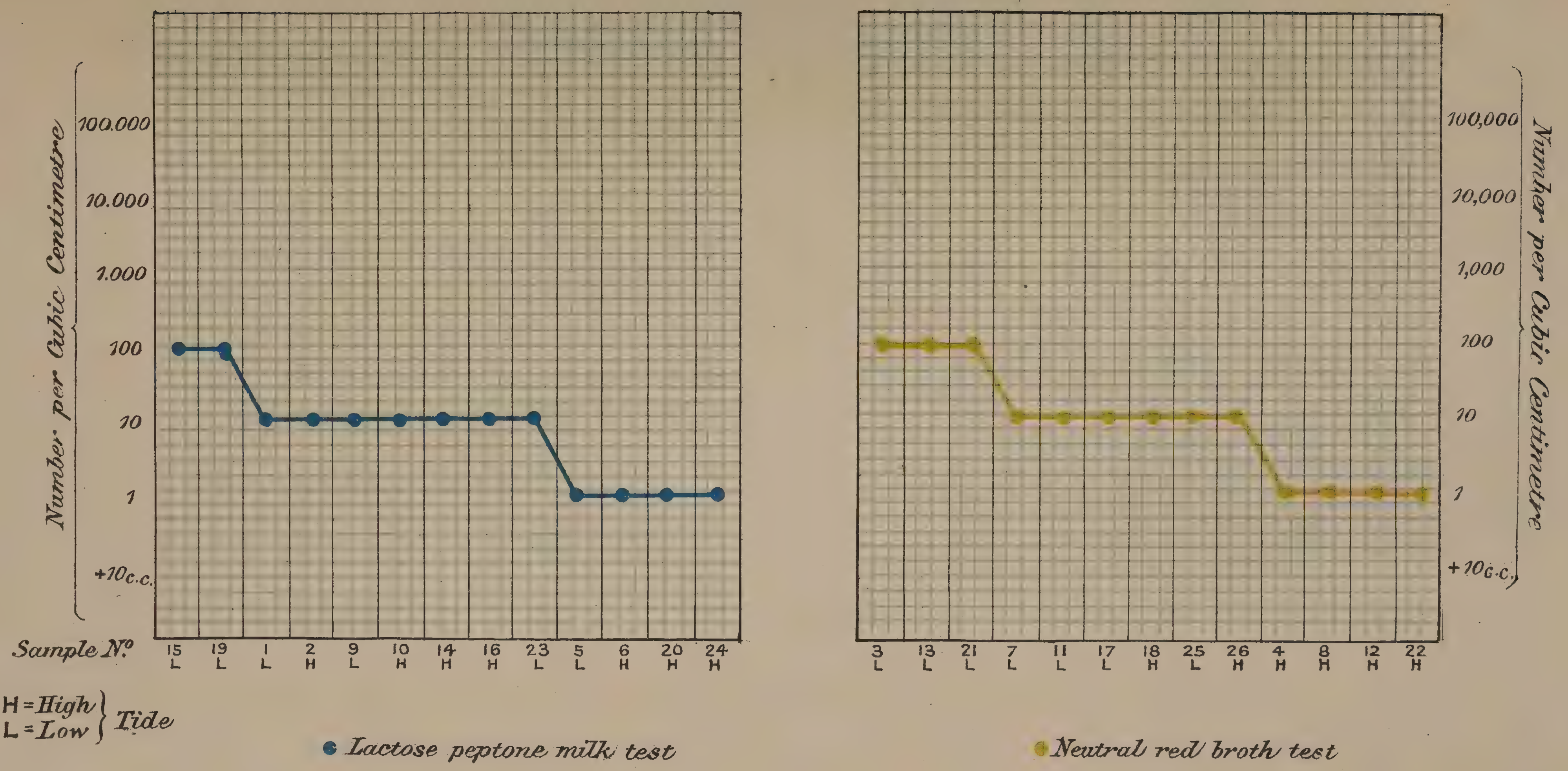
Diagram 14, showing the results of the Bacteriological Examination of the R. Thames off Mucking Lighthouse.



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Section IX.—*The condition of the River Thames at high and low tide at the Chapman Lighthouse.*

Division I.
Bacteriological
Examination
of the
River Thames
and Thames
Estuary.

The Chapman Lighthouse is about five miles below Mucking.

The results of the bacteriological examination of the River Thames at the Chapman Lighthouse are shown in Table 10 and Diagrams 15 and 16.

The results may be briefly summarised as follows :—

B. coli test - - - Lactose-peptone milk test, Neutral red broth test -	As regards the B. coli test, about half the samples gave a positive result with 1 c.c., and the other half a positive result with 10 c.c. but a negative result with 1 c.c. The lactose-peptone milk and neutral red broth tests yielded usually a positive result with 1 c.c.
B. enteritidis sporogenes test - - - -	The results varied from no spores in 10 c.c. to 1 spore per c.c., but usually the result was positive in 10 c.c. and negative in 1 c.c. (+ 10 c.c. ; − 1 c.c.).

The results under the circumstances must be regarded as very satisfactory, although it was still possible to show the presence in the water of excremental bacteria. The difference is striking between the biological quality of the River Thames at Purfleet (20 miles higher up) and at the Chapman.

A point that must not be lost sight of is that *pari passu* with the progressive improvement in the condition of the River Thames, the ratio of the numbers of coli-like microbes to the spores of B. enteritidis sporogenes became altered. That is, the normal great numerical superiority of the coli-like microbes became less and less apparent, and in certain of the Chapman samples the spores of B. enteritidis sporogenes were actually more numerous than the coli-like microbes. In all probability, this indicates the death of the coli-like microbes and tends to disprove the supposition that the improvement in the condition of the river is due merely to dilution or sedimentation.

As regards the biological characters of the coli-like microbes, 13 out of 19 were positive in all respects. One (otherwise typical) gave no indol reaction, one (otherwise typical) gave no clot in milk culture, four failed both as regards indol and clot.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 10 showing the results of the Bacteriological

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1		20	4	1903	Thames water off Chapman Lighthouse. High tide.	–	-	-	(Positive 10 c.c.)		- -
2		20	4	,,	Thames water off Chapman Lighthouse. Low Tide.	–	-	-	-	ditto	- -
3		27	4	,,	Thames water off Chapman Lighthouse. High tide.	–	-	-	-	ditto -	- -
4		27	4	,,	Thames water off Chapman Lighthouse. Low tide.	+	–				
5		5	5	,,	Thames water off Chapman Lighthouse. High tide.	+	–				
6		5	5	,,	Thames water off Chapman Lighthouse. Low tide.	+	–				
7		13	5	,,	Thames water off Chapman Lighthouse. High tide.	+	–				
8		13	5	,,	Thames water off Chapman Lighthouse. Low tide.	+	–				
9		19	5	,,	Thames water off Chapman Lighthouse. High tide.	–	-	-	(Positive 10 c.c.)		- -
10		19	5	,,	Thames water off Chapman Lighthouse. Low tide.	+	–				
11		26	5	,,	Thames water off Chapman Lighthouse. High tide.	–	-	-	(Positive 10 c.c.)		- -
12		26	5	,,	Thames water off Chapman Lighthouse. Low tide.	–	-	-	-	ditto -	- -
13		1	6	,,	Thames water off Chapman Lighthouse. High tide.	–	-	-	-	ditto -	- -
14		1	6	,,	Thames water off Chapman Lighthouse. Low tide.	–	-	-	(Positive 10 c.c)		- -
15		9	6	,,	Thames water off Chapman Lighthouse. High tide.	(Negative 10 c.c.)					
16		9	6	,,	Thames water off Chapman Lighthouse. Low tide.	–	-	-	(Positive 10 c.c.)		- -
17		16	6	,,	Thames water off Chapman Lighthouse. High tide.	+	–				
18		16	6	,,	Thames water off Chapman Lighthouse. Low tide.	+	–				
19		23	6	,,	Thames water off Chapman Lighthouse. High tide.	+	–				
20		23	6	,,	Thames water off Chapman Lighthouse. Low tide.	+	–				

Average results.	Less than 1 per c.c. but more than 1 per 10 c.c. is a fair average statement.

Examination of Thames Water at the Chapman Lighthouse.

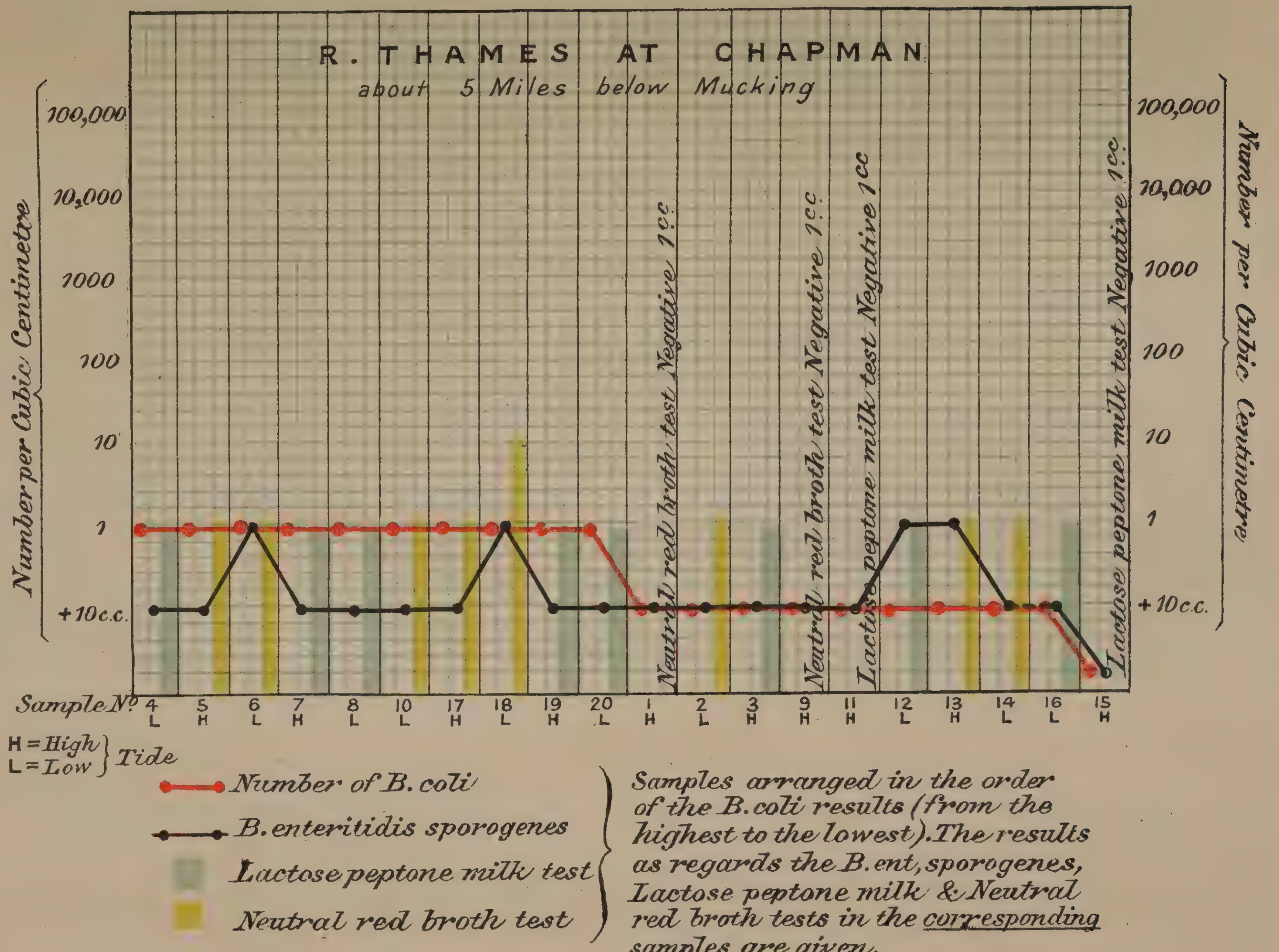
3.				4.						5.						6.
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						N.R. = Neutral Red broth test. + = Greenish yellow fluorescence. 48 hours at 37° C. L.P.M. = Lactose, Peptone, Milk test, + = Gas, acid and clot.						
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.).	Indol. (Broth cultures, 5 days at 37° C.).	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days, at 37° C.).		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	**Remarks.**
		(a)	(b)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+	+	+	+	–	-		- (Positive 10 c c.) -			–	N.R.					
+	+	+	+	–	-	-	- ditto -	-	-	+	–	N.R.				
+	–	+	+	–	-	-	- ditto -	-	-	+	–	L.P.M.				
+	+	+	+	–	-	-	- ditto -	-	-	+	–	L.P.M.				
+	–	+	–	–	-	-	- ditto -	-	-	+	–	N.R.				
+	+	+	+	+	–					+	–	N.R.				
+	+	+	+	–	-		- (Positive 10 c.c.) -		-	+	–	L.P.M.				
+	+	+	+	–	-	-	- ditto -	-	-	+	–	L.P.M.				
+	+	+	–	–	-	-	- ditto -	-	-	–	N.R.					
+	+	+	+	–	-	-	- ditto -	-	-	+	–	N.R.				
+	+	+	+	–	-	-	- ditto -	-	-	–	L.P.M.					
+	–	+	–	+	–					+	–	L.P.M.				
+	–	+	–	+	–					+	–	N.R.				
+	+	+	+	–	-		- (Positive 10 c.c.) -		-	+	–	N.R.				
				–	-		-(Negative 10 c.c.) -		-	–	L.P.M.					
+	+	+	+	–	-		- (Positive 10 c.c.) -		-	+	–	L.P.M.				
+	+	+	+	–	-	-	- ditto -	-	-	+	–	N.R.				
+	+	+	+	+	–						+	–	N.R.			
+	–	+	–	–	-		- (Positive 10 c.c.) -		-	+	–	L.P.M.				
+	+	+	+	–	-	-	- ditto -	-	-	+	–	L.P.M.				

3 out of 19 positive in all respects.
1 gave no indol reaction.
1 gave no clot in milk culture.
4 failed both as regards indol and clot.

Usually the result was :—present in 10 c.c., but less than 1 per c.c. (+ 10 c.c. ; – 1 c.c.).

Usually about 1 per c.c. (+ 1 c.c. – ·1 c.c.).

Diagram 15, showing the results of the Bacteriological Examination of the R. Thames at Chapman.



Samples arranged in the order of the B. coli results (from the highest to the lowest). The results as regards the B. ent. sporogenes, Lactose peptone milk & Neutral red broth tests in the corresponding samples are given.

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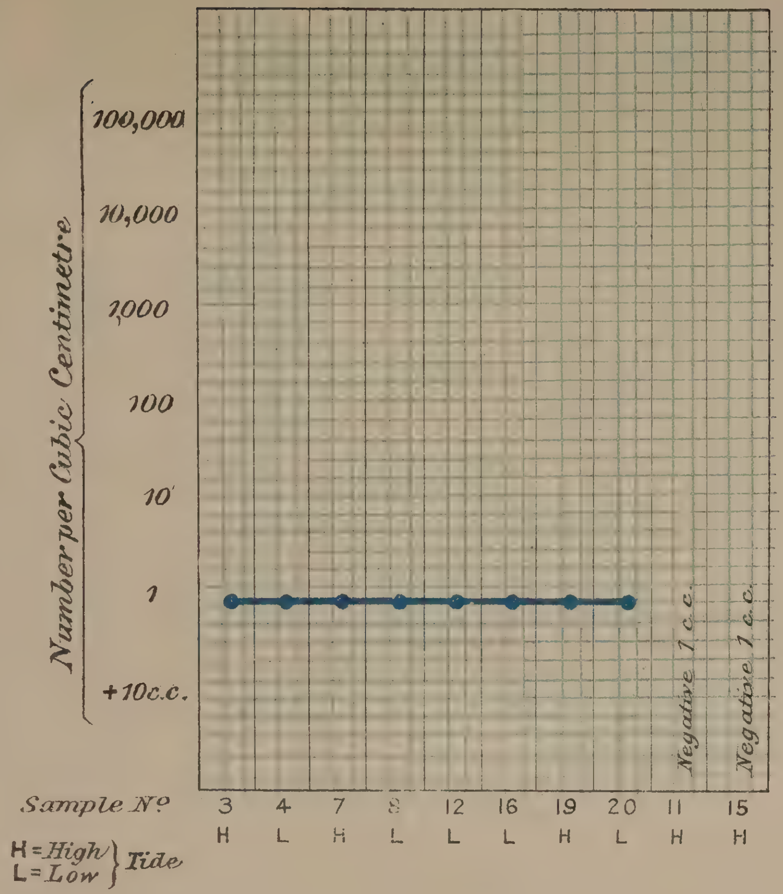
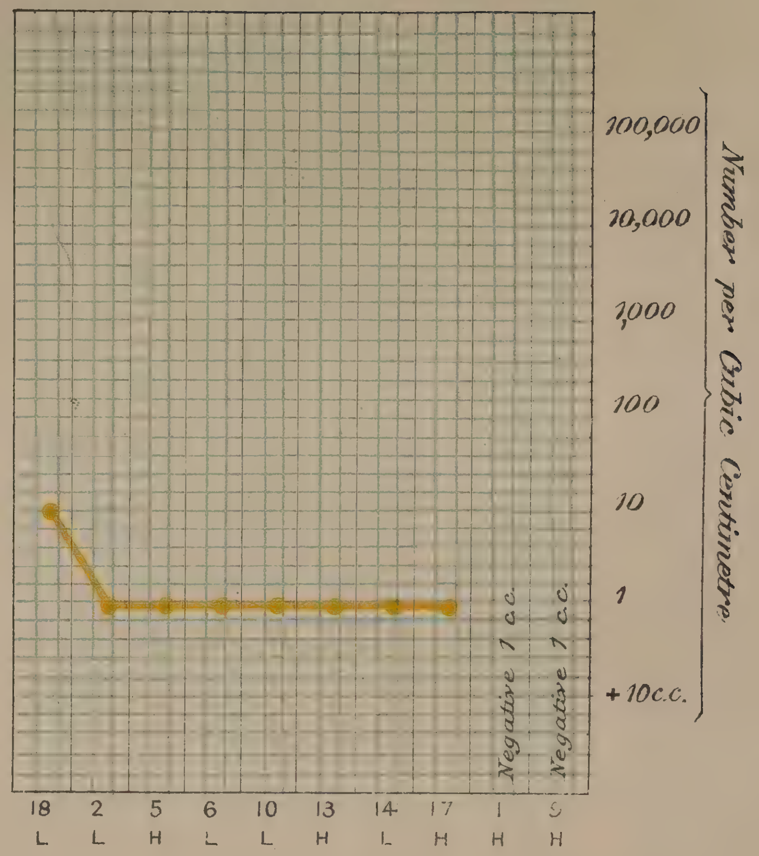
Examination of the R. Thames at Chapman.



● Lactose peptone milk test



● Neutral red broth test

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Section X.—*The condition of the water in Barrow Deep.**

Division 1.

Bacteriological Examination of the River Thames and Thames Estuary.

The entrance to Barrow Deep is about 13 miles seawards of the Nore and about 48 miles distant from Crossness.

Fifty thousand tons of sludge from the northern (Barking) and southern (Crossness) outfall works are discharged weekly into the Barrow Deep by the London County Council sludge steamers. The biological quality of this sludge has been given in Section III.†

The method of discharge‡ and other particulars will best be understood by reference to Appendix D, and by quoting from the evidence given before the Commission by Mr. Fitzmaurice, Engineer to the London County Council, as follows:—

> "When the sewage reaches the outfalls at Barking and Crossness, four grains of lime and one grain of proto-sulphate of iron are added to each gallon of sewage, so as to precipitate the matters in suspension.
>
> "As the sewage enters the outfall works, there are, on an average, at Barking, 33 grains of suspended matter per gallon of sewage; the effluent contains only 8 grains of suspended matter. Taking the difference between the two, although this cannot be absolutely accurate, we have 25 grains per gallon of suspended matter left in the precipitation channels.
>
> "The proportion of suspended matter and the amount precipitated is slightly different at Crossness.
>
> "The effluent is discharged into the river at Barking and Crossness, and it amounted during the year 1902 to a daily average of 232 million gallons.
>
> "The sludge left in the precipitation channels, 92 per cent. of which is water, is pumped into steamers which carry it away to the Barrow Deep, and it is there discharged over a length of from 5 to 10 miles.
>
> "There are six steamers for dealing with this sludge; each is capable of carrying about 1,000 tons, and they make, on an average, 10½ trips per week per steamer. One steamer is generally laid up for repairs.
>
> "The Barrow Deep is practically the open sea, being situated about 20 miles below Southend, and is not used for general navigation. By arrangement with the Trinity House no cargoes are discharged westward of an imaginary line drawn from the Maplin lightship to No. 10 buoy, which is about 5 miles eastward of the Mouse lightship. The ships carrying the sludge report to the Mouse lightship each time they pass both out and home. For this purpose each ship has a signal letter allotted to her, and hoists the letter flag by day, and the Mouse signal letter is flashed during hours of darkness. The time of passing the Mouse is noted and the reports from the lightship are compared with reports sent by the London County Council to the Thames Conservancy. Information is also sent to the Thames Conservancy of the number of times each vessel is loaded at the outfall works.
>
> "The distance from the Barking outfall to No. 10 buoy is about 48½ miles, and if the vessel steams 9½ miles while discharging the sludge, the total distance would be 58 miles, making 116 miles for the run out and home.
>
> "The maximum tide is at Gravesend Narrows, where at times it exceeds 4 knots an hour.
>
> "As far as possible it is arranged that the sludge shall be discharged on the ebb tide. The present fleet of six steamers would be unable to deal with the sewage unless they took advantage of going down on the ebb tide and coming back with the flood.
>
> "It has been suggested that the sludge should be carried a certain distance further to sea than is at present done. There is, of course, no impossibility in doing this, but it would mean a very large increase in the fleet, as the ships would have to run independently of whether it was flood or ebb.
>
> "He (Mr. Fitzmaurice) has made inquiries as regards the set of the current from the Barrow Deep on the flood tide, and from the information obtained it does not appear to set towards the Maplin sands, but rather straight east and west, with possibly a slight tendency towards the Medway.
>
> "The total amount of sludge sent to sea during the year 1902 was 2,607,000 tons, making a weekly average of 50,134 tons.
>
> "The cost of conveying the sludge to sea amounted to 2·76 pence per ton for the year 1902. The cost of the six sludge steamers was £145,697."

The results of the bacteriological examination of the water in the Barrow Deep are shewn in Table 11 and Diagrams 17 and 18.

---

* Details relating to the collection of the samples are given in Appendix A.

† The Thames Conservancy Authorities also discharge "dredgings" in this neighbourhood.

‡ I have personally inspected the whole process of sludge disposal in the Barrow Deep. My topographical observations led me to form a favourable opinion of the method.

Division 1.

Bacteriological Examination of the River Thames and Thames Estuary.

The results may be summarised briefly as follows :—

B. coli test - - -	The B. coli results varied from none in 10 c.c. to 10 per c.c. Usually, however, the result was either + 10 c.c., — 1 c.c., or + 1 c.c., — 0·1 c.c.
Lactose-peptone milk test -	The lactose-peptone milk results varied from + ·1 c.c. to — 1 c.c.
Neutral red broth test -	The neutral red broth test usually gave a positive result with 1 c.c.
B. enteritidis sporogenes test - - - -	The results varied from — 10 c.c. to + ·1 c.c. About half the samples gave a positive result with 1 c.c., and about one-third a positive result with 10 c.c. but a negative result with 1 c.c.

These results are certainly satisfactory, when it is remembered that each week 50,000 tons of sludge containing per c.c. from one million to ten thousand million B. coli and ten thousand to one hundred thousand spores of B. enteritidis sporogenes is discharged into Barrow Deep.

The ultimate fate of this vast horde of microbes is matter for conjecture, but the actual result is beyond question most satisfactory. No doubt many of the microbes sink gradually to the bottom and there undergo dissolution. Others are probably swept far out to sea (eastwards) on the ebbing tide, and may never perhaps return. Others, again, may be carried outside the limits of the channel, either in a lateral direction (north or south), or backwards (westwards) on the flowing tide towards the Nore. But there seems no reason to doubt that a large proportion of the non-sporing bacilli, at all events, perish in the water within the area of discharge.* In this connexion, it is worthy of note that in many of the samples the normal numerical superiority of B. coli over B. enteritidis sporogenes was reversed, *i.e.*, the spores of the latter microbe were present in larger proportion than B. coli. It is difficult to believe in the possibility of the discharge of the sludge in the Barrow Deep fouling the sea water outside the limits of the channel to an appreciably greater extent than in the channel itself. It has been shown that the condition of the water in the Barrow Deep, as also the River Thames at the Chapman Lighthouse, is most satisfactory considering the circumstances.

It follows, therefore, that results of bacteriological analysis do not substantiate the alleged *gross* pollution of the Thames Estuary and the Essex and Kentish coasts (east of a line connecting the Chapman Lightship with Stoke) due to the discharge of chemically treated sewage into the Thames at Barking and Crossness, and sludge into the Barrow Deep.† On the contrary, the results appear to indicate that outside the Barrow Deep and beyond the Chapman Lighthouse the excremental bacteria derived from the sludge and effluents respectively must be present in such small proportion in the sea water as, practically speaking, to be almost if not quite negligible. The statements that have been made to the contrary appear to have been based on conjecture.

---

* The area of discharge may be said to be about 10 miles long, about 1 to 2 miles broad, and about 6 to 13 fathoms deep at low-water spring tides.

† The idea underlying the method of collecting samples was that on each occasion the A samples should be collected from the bows of the first and the B samples from the bows of the last vessel of the fleet. A sample would thus show how far the water had recovered since the previous visit of the fleet, and B sample would represent the worst condition of the water since it was taken, although at some distance, in the wake of the preceding boats. At first A and B samples were chance samples; later in the investigation, however, average samples were also collected. To have collected samples from the *stern* of the vessel during discharge would, of course, have been useless for the purposes of this investigation. Information was required as regards the biological quality of the water in the Barrow Deep, not of the sludge, before any mixture with the sea water in proper proportions could possibly have occurred. The composition of the sludge has already been given in Section III.

TABLE 11.

Showing the Results of the Bacteriological Examination of the Water in Barrow Deep.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 11 showing the Results of the Bacteriological

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1A	2.30 p.m.	24	2	1903.	*Barrow Deep*, Steamship "Barking" No. 6 Buoy, tide three-quarter ebb, 1st boat to discharge.	−					
1B	4.25 p.m.	24	2	,,	*Barrow Deep*, Steamship "Belvedere,' No. 3 Buoy, mid-channel, nearly low water.		+	−			
2A	6.15 a.m.	3	3	,,	*Barrow Deep*, Steamship "Belvedere," No. 3 Buoy, tide about three-quarter ebb.	+	−				
2B	8.15 a.m.	3	3	,,	*Barrow Deep*, Steamship "Binnie," No. 6 Buoy, just before low water.		+	−			
3A	12 noon	10	3	,,	*Barrow Deep*, Steamship "Burns" No. 10 Buoy, tide half ebb.	(Negative 10 c.c.)					
3B	3.50 p.m.	10	3	,,	*Barrow Deep*, Steamship "Binnie,' No 6 Buoy, last quarter ebb tide.	+	−				
4A	6.50 a.m.	17	3	,,	*Barrow Deep*, Steamship "Barrow," No 6 Buoy, two hours before low water.	−					
4B	9 a.m.	17	3	,,	*Barrow Deep* Steamship "Burns," No 10 Buoy low water.	-	-	-	See Remarks -	-	-
5A	12.54 p.m.	24	3	,,	*Barrow Deep*, Steamship "Bazalgette," No 5 Buoy, two-thirds ebb tide.	-	-		(Negative 10 c.c.)	-	-
5B	1.55 p.m.	24	3	,,	*Barrow Deep*, Steamship "Burns," No 10 Buoy, last of ebb tide.	+	−				
(1)		25	3	,,	*Barrow Deep*, Steamship "Burns," No. 10 Buoy, outward journey, before discharge.	−	-	-	(Positive 10 c.c.)	-	-
(8)		25	3	,,	*Barrow Deep*, Steamship "Burns," No. 10 Buoy, return journey.						
(2)		25	3	,,	*Barrow Deep*, Steamship "Burns," between No. 10 and 6 Buoy, average sample, every two minutes, outward journey.	−	-	-	(Positive 10 c.c.)	-	-
(3)		25	3	,,	Same as (2) but between No. 6 and 4 Buoy.						
(4)		25	3	,,	Same as (2) but between No. 4 and 2 Buoy.						
(5)		25	3	,,	Below No. 2 Buoy, taken while steamer circling round for return journey.	+	−				
(6)		25	3	,,	Same as (2) but between No. 2 and 6 Buoy, return journey.	−	-	-	(Positive 10 c.c.)	-	-
(7)		25	3	,,	Same as (6) but between No. 6 and 10 Buoy.						
6A		31	3	,,	*Barrow Deep*, Steamship "Belvedere," average sample from No. 10 to 1 Buoy, collected every two minutes, tide two-thirds ebb.	+	−				
6B		31	3	,,	*Barrow Deep*, Steamship "Burns," average sample from No. 1 to 10 Buoy collected every two minutes, low water.	+	−				
7A		1	4	,,	*Barrow Deep*, Steamship "Barking," average sample from No. 10 to 2 Buoy collected every two minutes, last quarter ebb.	+	−				

Examination of the Water in the Barrow Deep.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

3.				4.						5.						
hief Biological Characters of he *strain* of B. Coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence, 48 hours at 37° C. L.P.M. = Lactore, Peptone Milk. + = Gas, acid and clot.						**REMARKS.**
Gas. Gelatine "shake" ultures, 24 hours t 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	
				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
		(a)	(b)													
				–							+	–	L.P.M.			
+	+	+	+	+	–					+	–	L.P.M.				
+	+	+	+	+	–					+	–	N.R.				
+	+	+	+	+	–						+	N.R.				
					+	–				–	L.P.M.					
+	+	+	+	+	–						+	L.P.M.				
				–	-	-	(Positive 10 c.c.) -	-	-	+	–	N.R.				
-	See Remarks	-	-	-	-	See Remarks		-	-	-	-	See Remarks.		-	-	Sample 4B was unfortunately broken.
				–	-	-	(Positive 10 c.c.) -	-	-	–	L.P.M.					
+	+	+	+	+	–					–	L.P.M.					
+	+	+	+	–	-	-	(Positive 10 c.c.) -	-	-	-	-	No Record	-	-	-	Samples Nos. (1) and (8) were mixed together in equal proportion and the mixed liquid examined.
+	+	+	+	–	-	-	(Positive 10 c.c.) -	-	-	-	-	No Record	-	-	-	Samples (2), (3), and (4) were also mixed together. So also were Samples (6) and (7).
+	+	+	+	+	–					-	-	No Record.				
+	+	+	+	–	-	-	(Positive 10 c.c.) -	-	-	-	-	No Record.				
+	+	+	+	+	–						+	–	N.R.			
+	+	+	+	+	–					+	–	N.R.				
+	+	+	+	–	-	-	(Positive 10 c.c.) -	-	-	+	–	N.R.				

vision I.

Bacteriological Examination of the RiverThames and Thames Estuary.

TABLE 11 showing the Results of the Bacteriological Examination

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,00
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
7B		1	4	1903.	*Barrow Deep*, Steamship "Barking," average sample from No. 1 to 10 Buoy, collected every two minutes, nearly low water.	+	–				
8A		7	4	,,	*Barrow Deep*, Steamship "Binnie,' average sample from No. 10 to 3 Buoy, collected every two minutes, about half ebb tide.		- - No record.				
8B		8	4	,,	*Barrow Deep*, Steamship "Barrow," average sample from No. 1 to 10 Buoy, collected every two minutes, nearly low water.						
9A		15	4	,,	*Barrow Deep*, Steamship "Barrow," average sample from No. 1 and 3 Buoy, collected every two minutes, tide two-thirds ebb.	-	- Negative 10 c.c. - -				
9B		15	4	,,	*Barrow Deep*, Steamship "Binnie," average sample from No. 3 to 10 Buoy, collected every two minutes, last quarter ebb.	–	- - (Positive 10 c.c.) - -				
10A		21	4	,,	*Barrow Deep*, Steamship "Binnie," average sample from No. 3 to 8 Buoy, collected every two minutes, last quarter ebb tide.	+	–				
10B		21	4	,,	*Barrow Deep*, Steamship "Barrow," average sample from No. 3 to 1 Buoy, collected every two minutes, after low water.	+	–				
11A		22	4	,,	*Barrow Deep*, Steamship "Binnie," average sample from No. 10 to 6 Buoy, collected every two minutes, last quarter ebb tide.	–	- - (Positive 10 c.c.) - -				
11B		22	4	,,	*Barrow Deep*, Steamship "Barrow," average sample from No 1 to 10 Buoy, collected every two minutes, first quarter flood.		+	–			
12A		23	4	,,	*Barrow Deep*, Steamship "Binnie," average sample from No. 10 to 1 Buoy, collected every two minutes, tide half ebb.	–	- - (Positive 10 c.c.) - -				
12B		23	4	,,	*Barrow Deep*, Steamship "Barrow," average sample from 1 to 10 Buoy, collected every two minutes, low water.	–	- - (Positive 10 c.c.) - -				
					Average results - -	The results varied from none in 10 c.c. to 10 per c.c. Usually, however, the result was either + 10 c.c. –1 c.c., or +1 c.c. - 0·1 c.c.					

of the Water in the Barrow Deep—*continued*

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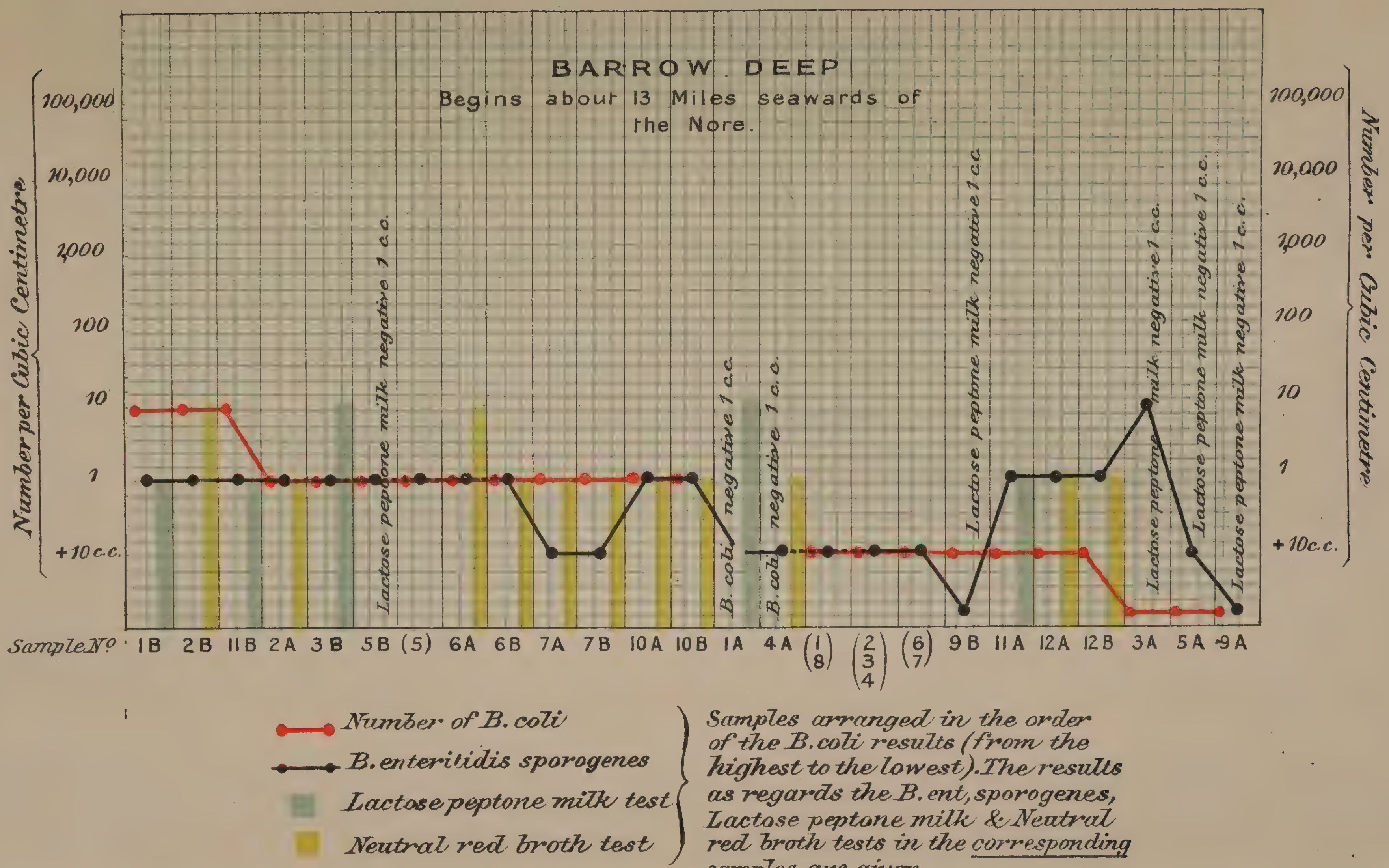
Bacteriological Examination of the River Thames and Thames Estuary.

3. Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				4. B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anaerobic milk cultures). Cultures heated to 80° C. for 10 minutes.						5. N.R. = Neutral Red Broth test. + = Greenish-yellow fluorescence, 48 hours at 37° C. L.P.M. = Lactose, Peptone, Milk. + = Gas, acid and clot.						6.
Gas, (Gelatine, "shake" cultures, 24 hours at 20° C.).	Indol. (Broth cultures, 5 days at 37° C.).	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days, at 37° C.).		1	10	100	1,000	10,000	100,000	1	10	100	1,000	10,000	100,000	REMARKS.
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+	+	+	+	–	-	(Positive 10 c.c.)				+	–	N.R.				
						No Record							No Record.			
				-	-	Negative 10 c.c.				–	L.P.M.					
+	+	+	+	-	-	Negative 10 c.c.				–	L.P.M.					
+	+	+	+	+	–					+	–	N.R.				
+	+	+	+	+	–					+	–	N.R.				
+	+	+	+	+	–					+	L.P.M.					
+	–	+	+	+	–					+	–	L.P.M.				
+	+	+	+	+	–					+	–	N.R.				
+	+	+	+	+	–					+	–	N.R.				
19 out of 20 positive in all respects. 1 gave no indol reaction.				The results varied from – 10 c.c. to + ·1 c.c. About half the samples gave a positive result with 1 c.c., and about one-third a positive result with 10 c.c., but a negative result with 1 c.c.						The lactose-peptone milk results varied from + ·1 c.c. to – 1 c.c. The neutral-red broth test usually gave a positive result with 1 c.c.						

Examination of the water in the Barrow Deep.



Samples arranged in the order of the B. coli results (from the highest to the lowest). The results as regards the B. ent. sporogenes, Lactose peptone milk & Neutral red broth tests in the corresponding samples are given.

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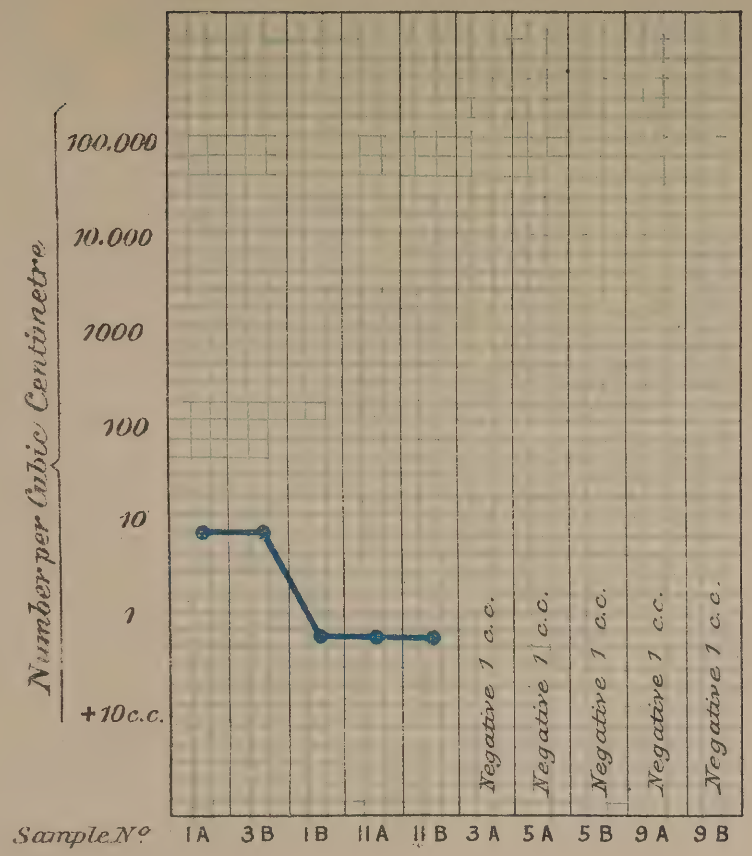
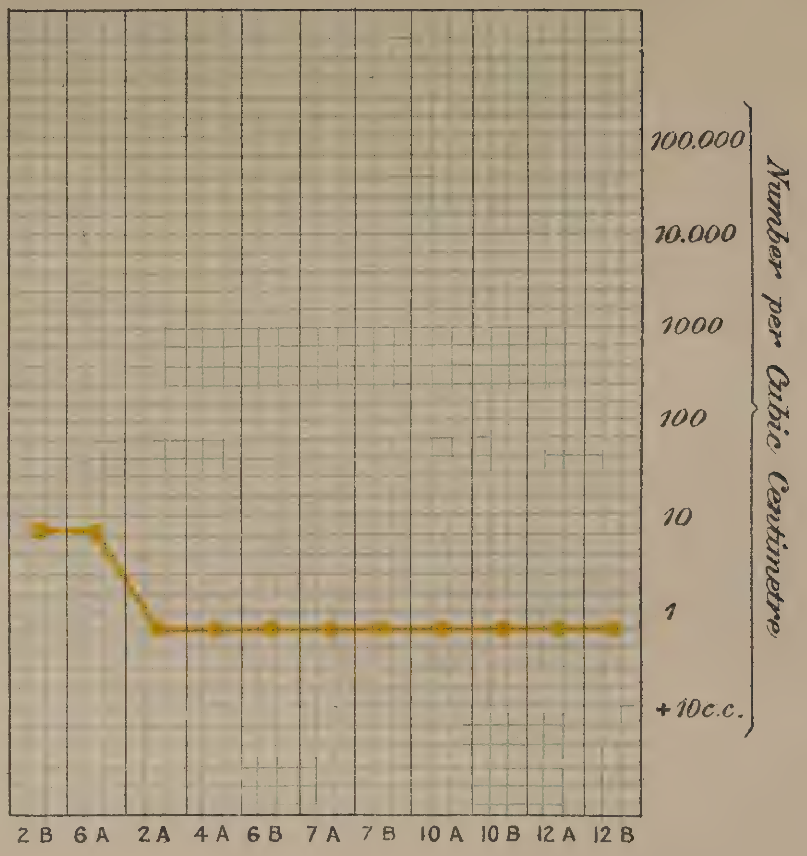
Diagrams showing the results of the Bacteriological Examination of the water in the Barrow Deep.



● Lactose peptone milk test



● Neutral red broth test

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Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Section XI.—*The bacteriological examination of London filtered water.**

As the Commission were desirous of ascertaining, for comparative purposes, the bacteriological condition of the London filtered water, some analyses were made of samples of water from the *mains* of the East London and of the Southwark and Vauxhall Companies (*see* Tables 12 and 13). It was, of course, impossible to enter into the subject at all fully, so that it would be unwise to draw other than provisional inferences from the results.

With one exception (No. 6, East London main water), none of the samples contained B. enteritidis sporogenes in 10 c.c.

The B. coli results, however, were the reverse of satisfactory, although it is worthy of note that not a few of the coli-like microbes isolated from the samples were in one or more respects not completely typical of B. coli. Still, the not infrequent presence of coli-like microbes in 1 c.c. of the implicated water, and the isolation, from either 1, 10, or 100 c.c. of the waters, in not a few instances of seemingly altogether typical B. coli, cannot be regarded as other than unsatisfactory. Having regard to the meteorological conditions prevailing during the period of collection, it is possible that these results do not truly represent the average condition of the filtered waters.

It will, I think, be accepted that the results indicate that microbes of presumably intestinal derivation were passing through the filter beds of the East London and of the Southwark and Vauxhall Waterworks Companies. It may, perhaps, be contended that, as no untoward result followed this bacterial manifestation of *potential* danger to health, the presence of B. coli in drinking water is of small practical moment. Such contentions are frequently advanced without adequate regard to the importance and complexity of the problems which underlie the whole question. On the other hand, and in this connexion, the danger of generalising from particular cases must be emphasised. Further, it must not be forgotten that the B. coli test is an index of excremental, not of specific, pollution. Nevertheless, it is conceivable that a fortuitous chain of circumstances might convert a potential into an actual and menacing danger to health. It is at all events conceivable, although happily unlikely if not extremely improbable, that, coincident with a breakdown in the filtering arrangements, a widespread epidemic of enteric fever might occur in one or more of the towns discharging sewage or imperfectly purified effluents into the Thames or Lea above the intake of the waterworks companies. Statistics which seek to prove biological purity of London water on the basis of the comparatively low incidence of enteric fever in London over a long term of years would, in the face of such a catastrophe, become altogether discredited.

The continuous passage in any number through filters of bacteria, seemingly of excremental origin, ought to be looked on in the light of evidence of inherent weakness in the system, a weakness which, perhaps, need never be exaggerated to the pitch of a complete breakdown in the process, but which always suggests the possibility of danger.

It is not desirable to push unduly the question of *potential* danger to health; nevertheless, it is quite possible to go to the other extreme and, trusting too much to lack of evidence of obvious harmfulness in particular cases, wrongly to infer that under other circumstances, even if they appear to be broadly parallel, a similar state of security would uniformly be obtained.

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* In Appendix C extracts are given from the Government Analyst's report on the Metropolitan water supply during May and June 1903.

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Bacteriological Examination of the River Thames and Thames Estuary.

The very magnitude of the scale of operations of the London waterwork companies may render safe procedures which, carried out on a smaller scale might not always be so apparently successful.

The results of these bacteriological testings of London water supply which I have undertaken would seem to lend confirmation to the old-established view that filtration is a relative, not an absolute, safeguard. They suggest that the intrinsic and indisputably objectionable biological qualities of the water before filtration were not sufficiently modified by the process of filtration, although doubtless the total number of microbes suffered a marked diminution.

At the same time, the results might fairly be used as an argument against condemning water owing to the mere presence of B. coli or gas-forming coli-like microbes, as has been the practice in the past to a large extent, irrespective of their relative abundance in the samples, seeing that in this instance water was being drunk, without obvious detriment to health, which uniformly contained B. coli or coli-like microbes in 100, in 10, and sometimes even in 1 c.c.

TABLE 12.

Showing the Result of the Bacteriological Examination of East London Main Water.

TABLE 12 showing the Result of the Bacteriological

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1		5	6	1903	East London main water -	– Characters of coli from the 100 c.c. culture	-	-	(Positive 10 c.c.)	-	-
2		9	6	,,	- ditto - - ditto -	Positive 100 c.c., negative 10 c.c.					
3		10	6	,,	- ditto - - ditto -	– Characters of coli from the 100 c.c. culture	-	-	(Positive 10 c.c.)	-	-
4		11	6	,,	- ditto - - ditto -	– Characters of coli from the 100 c.c. culture	-	-	(Positive 10 c.c.)	-	-
5		16	6	,,	- ditto - - ditto -	– Characters of coli from the 100 c.c. culture	-	-	(Positive 10 c.c.)	-	-
6		17	6	,,	- ditto - - ditto -	+ Characters of coli from the 10 c.c. culture -	–				
7		19	6	,,	- ditto - - ditto -	+ Characters of coli from the 10 c.c. culture - Characters of coli from the 100 c.c. culture	–				
8		22	6	,,	- ditto - - ditto -	– Characters of coli from the 100 c.c. culture	-	-	(Positive 10 c.c.)	-	-
9		25	6	,,	- ditto - - ditto -	– No coli seemingly in 100 c.c. culture but B. pyocyaneus isolated from it (*see* Remarks).†	-	-	(Positive 10 c.c.)	-	-
10		29	6	,,	- ditto - - ditto -	Positive 100 c.c., negative 10 c.c.					

3.							4.						5.
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.							B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. elatine "shake" ultures, 4 hours 20° C.).	Indol. (Broth cultures, 5 days at 37° C.).	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days, at 37° C.).		Lactose-peptone, medium, + = acid and gas.	Lactose-peptone milk, medium, + = acid, gas and clot.	Neutral red broth, + = greenish-yellow fluorescence.	1	10	100	1,000	10,000	100,000	
		(a)	(b)				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+*	–	+	+	+	+	+	-	-	Negative 10 c.c.			- -	* The microbe slowly liquefied gelatine.
+*	–	+	–	Slight bleaching, no gas.	Bleached, gas, slight clot.	–							
+	+	+	+	+	+	+	-	-	-	ditto.			
+	+	+	+	+	+	+	-	-	-	ditto.			
+	+	+	+	+	+	+							
+	+	+	+	+	+	+	-	-	-	ditto.			
+*	–	+	+	+	Bleached, slight gas, and clot.	+							
+	+	+	+	+	+	+	-	-	-	ditto.			
+*	–	+	–	–	Acid, slight gas, slight clot.	+							
+	+	+	+	+	+	+	–	-	-	(Positive 10 c.c.).			
+	+	+	+	+	+	+							
+	+	+	–	–	Slight acid, no gas, no clot.	? +	-	-	Negative 10 c.c.				
+*	–	+	+	Slight bleaching, no gas.	+	+							
+	+	+	–	+	+	+							
+*	+	+	+	–	–	+	-	-	-	ditto.			
+*	-	+	+	–	Bleached, slight gas, no clot, atypical.	+							
+*	–	+	+	–	Bleached, slight gas and clot, atypical.	+		-	-	ditto	-	- -	† A microbe indistinguishable from B. pyocyaneus was isolated from 100 c.c. of Sample. 1 c.c. of a broth culture of this microbe after 24 hours at 37° C. was injected subcutaneously into a guinea-pig. The animal died within 48 hours.
+	+	+	+	+	+	+	-	-	-	ditto.			

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Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 13 showing the Results of the Bacteriological

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.		1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1		5	6	1903	Southwark and Vauxhall main water.	+	–				
						Characters of coli from the 10 c.c. culture -					
2		9	6	„	- ditto - ditto -	+	–				
						Characters of coli from the 10 c.c. culture -					
3		10	6	„	- ditto - - ditto -	+	–				
						Characters of coli from the 10 c.c. culture -					
4		11	6	„	- ditto - - ditto -	+	–				
						Characters of coli from the 10 c.c. culture -					
5		15	6	„	- ditto - - ditto -	–	- -		(Positive 10 c.c.)		- -
						Characters of coli from the 100 c.c. culture					
6		16	6	„	- ditto - - ditto -	+	–				
						Characters of coli from the 10 c.c. culture					
7		17	6	„	- ditto - - ditto	Positive 100 c.c., negative 10 c.c.					- -
8		22	6	„	- ditto - - ditto -	–	- -		(Positive 10 c.c.)		- -
						Characters of coli from the 100 c.c. culture					
9		25	6	„	- ditto - - ditto -	+	–				
						Characters of coli from the 10 c.c. culture					
10		29	6	„	- ditto - - ditto -	–	- -		(Positive 10 c.c.)		- -
						Characters of coli from the 100 c.c. culture					

Examination of Southwark and Vauxhall Main Water.

3. Chief Biological Characters of the strain of B. Coli present in number specified in Col. 2.							4. B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis" change in anaerobic milk culture). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas Gelatine 'shake" cultures 24 hours t 20° C.)	Indol (Broth cultures, 5 days at 37° C.)	(a) Acidity (b) Clot. (Litmus milk cultures, 5 days, at 37° C.)		Lactose-peptone medium + = acid and gas.	Lactose-peptone milk medium + = acid, gas and clot.	Neutral red broth + = greenish-yellow fluorescence.	1	10	100	1,000	10,000	100,000	
		(a)	(b)				1 c.c	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+*	–	+	+	+	+	+	-	-	Negative 10 c.c.			- -	*The microbe slowiy liquified gelatine.
+	+	+	+	+	+	+							
+*	–	+	+	Bleached, no gas.	Slight acid and gas, no clot.	? –	-	-	-	ditto.			
+*	–	+	+	Slight Bleaching, no gas.	Bleached, slight gas and clot.	+							
+*	–	+	–	Bleached, slight gas.	Acid, gas, no clot.	? +	-	-	-	ditto.			
+*	–	+	–	Bleached, no gas.	Acid, gas, no clot.	+							
+	–	+	+	+	+	+	-	-	-	ditto.			
+	–	+	+	+	+	+							
+	–	+	–	–	Acid, slight gas, no clot.	+	-	-	-	ditto.			
+	Trace.	+	+	+	+	+							
+	+	+	+	+	+	+	-	-	-	ditto.			
+*	–	+	–	–	Bleached, ? trace gas, no clot.	–							
+	+	+	+	+	+	+	-	-	-	ditto.			
+	+	+	+	+	+	+	-	-	-	ditto.			
+*	+	+	+	–	Slight acid and gas, no clot.	+							
+	+	+	+	+	+	+	-	-	-	ditto.			
+	+	+	+	+	+	+							
+	+	+	+	+	+	+	-	-	-	ditto.			
+	+	+	+	+	+	+							

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Summary of Results.

In Diagrams 19 to 23 the Sunbury, Hampton, Barking, Crossness, Purfleet, Grays, Mucking, Chapman, and Barrow Deep results, are brought into comparison, as regards the B. coli and B. enteritidis sporogenes tests.

B. coli test:—Diagram 19 shows the results as regards the number of coli-like microbes present. It will be noted that practically speaking the Barking, Crossness, and Purfleet results are comparable, and that generally the number of B. coli or coli-like microbes varied from 100 to 1,000 per c.c. The Crossness results were the worst, and the Purfleet and Barking not widely different, but of these two the Barking results were perhaps slightly the better.

Then comes Grays, so to speak in a class by itself, the results varying from 10 to 1,000, but usually 100, coli-like microbes per c.c.

Next come Hampton and Sunbury, usually containing 10 to 100 B. coli or coli-like microbes per c.c., but more often 10 than 100. The Hampton results were seemingly slightly the better.

Mucking stands by itself, the results varying from 1 to 100 B. coli or coli-like microbes per c.c. Rather more than half the samples contained 10, about one-third contained 1, and about one-tenth contained 100, B. coli or coli-like microbes in 1 c.c.

The Chapman and Barrow Deep results are broadly comparable, and usually a positive result with regard to coli-like microbes was obtained with either 10 c.c. or 1 c.c. of the water.

Some hesitation is entertained in comparing Southwark and Vauxhall and East London filtered waters with the above results. Nevertheless it might be contended with some show of reason that the filtered water was not at all events conspicuously better as regards the number of coli-like microbes than the water at Chapman Lighthouse and Barrow Deep.

The waters may be arranged in order as follows:—

River Thames at :—	*B. coli* (*or gas-forming coli-like microbes*) *per c.c.* :—
Crossness Purfleet Barking	About 100 to 1,000 per c.c.
Grays	10 to 1,000, but more usually 100 per c.c.
Hampton Sunbury	Usually 10 to 100, but more often 10 than 100 per c.c.
Mucking	1 to 100; more often 10 than 1, but very seldom 100 per c.c.
Chapman Barrow Deep	Ranged usually from 1 in 10 c.c. to 1 in 1 c.c.

Stated generally, the River Thames at Crossness, Purfleet, Barking, and Grays contained over 100; at Hampton, Sunbury, and Mucking over 10, and at the Chapman and the Barrow Deep often less than 1 B. coli or coli-like per c.c.

As an unequal number of samples from the several sources were subjected to examination, it is necessary to call attention to Table 14 and Diagrams 20 and 21. In this table and in these diagrams the results are brought into comparison by a percentage method of classification.

In Table 15 is shewn the percentage number of coli-like microbes isolated from the different waters responding to various tests for B. coli.

Table 14, showing the Percentage Number of Samples out of the Total Number examined in each Case containing B. Coli (or allied forms) in the Number specified below.

River Thames at:—	Percentage Number of Samples, out of the Total Number examined in each Case, containing B. Coli (or allied forms) in the Number specified below.								Total Number of Samples Examined.
	− 10 c.c.	+ 10 c.c. − 1 c.c.	+ 1 c.c. − ·1 c.c.	+ ·1 c.c. − ·01 c.c.	+ ·01 c.c. − ·001 c.c.	+ ·001 c c. − ·0001 c.c.	+ ·0001 c.c. − ·00001 c.c.	+ ·00001 c.c. − ·000001 c.c.	
	None in 10 c.c.	Present in 10 c.c., but less than 1 per c.c.	At least 1 per c.c.	At least 10 per c.c.	At least 100 per c.c.	At least 1,000 per c.c.	At least 10,000 per c.c.	At least 100,000 per c.c.	
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.		
Sunbury	—	—	—	70·6	23·5	5·9	—	—	17
Hampton	—	—	11·8	64·7	17·7	5·9	—	—	17
Barking	—	—	—	4·2	45·8	45·8	4·2	—	24
Crossness	—	—	—	11·1	27·7	50·0	11·1	—	18
Purfleet	—	—	3·0	9·1	33·3	39·1	15·1	—	33
Grays	—	—	2·8	22·2	41·7	33·3	—	—	36
Mucking	—	—	30·8	57·7	11·5	—	—	—	26
Chapman	5	45	50	—	—	—	—	—	20
Barrow Deep*	12	36	40	12	—	—	—	—	25

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* In two cases no 10 c.c. cultures were made, but the results were negative in 1 c.c. These have been classed as + 10 c.c., − 1 c.c.

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Bacteriological Examination of the River Thames and Thames Estuary.

TABLE 15, showing the percentage number of coli-like microbes isolated from the different waters responding to the various tests for B. Coli.

Name of Place.	Percentage number of Coli-like microbes reacting positively to all the tests employed.	Percentage number of Coli-like microbes giving no Indol reaction (otherwise typical) in broth culture (5 days at 37° C.)	Percentage number of Coli-like microbes giving no clot (otherwise typical) in milk culture (5 days at 37° C.)	Percentage number of Coli-like microbes giving neither Clot nor Indol.	Number of cultures examined.
Sunbury - - -	64·7	17·6	5·8	11·7	17
Hampton - -	76·5	5·8	11·7	5·8	17
Barking - - -	91·7	0	0	8·3	24
Crossness - -	61·1	11·1	16·6	11·1	18
Purfleet - - -	65·6	3·1	6·2	25·0	32
Grays - - -	66·6	13·9	13·9	5·5	36
Mucking - - -	61·5	7·7	7·7	23·1	26
Chapman - -	68·4	5·2	21·0	5·2	19
Barrow Deep - -	95	5·0	0	0	20

Lactose-peptone milk and neutral red broth tests.

There can be no question that, exceptional cases apart, these tests yielded throughout the investigation results *broadly* parallel with the B. coli test. These simple tests, although not in all cases implicitly to be trusted, may be of considerable practical value, provided some discrimination be used in the interpretation of the results. For example, as has been pointed out on more than one occasion, both as regards these tests and the indol test, whenever the number of spores of bacteria present in the sample is excessive, due circumspection must be exercised in interpreting the results.

B. enteritidis sporogenes test.

Diagram 22 shows the results as regards the B. enteritidis sporogenes test.

Practically speaking the Crossness, Purfleet, Barking, and Grays results are comparable, and the above order perhaps expresses fairly the degree of impurity, Crossness being the most impure. 1 to 10 spores per c.c., but more often 10 than 1 is a fair estimate.

Next comes Mucking with1 to 10, but more often 1 than 10, spores per c.c. As regards this test, Mucking water was more impure than the water at Sunbury and Hampton. It will be remembered that in respect of the B. coli test the reverse was noted.

The Barrow Deep would seem to come next owing, I think, to the enormous number of spores in the sludge deposited there. Here the results of bacteriological examination of the sea water were usually either 1 spore per 10 c.c., or 1 spore in 1 c.c., but most often the latter.

In the next place come Sunbury and Hampton, with results varying usually from 1 spore per 10 c.c. to 1 spore in 1 c.c., but rather more often 1 spore in 10 c.c.

Diagram 19 showing, as regards B. Coli, the results of the Bacteriological Examination of the River Thames at Hampton, Sunbury, Barking, Crossness, Purfleet, Grays, Mucking & Chapman & of the sea water in Barrow Deep.

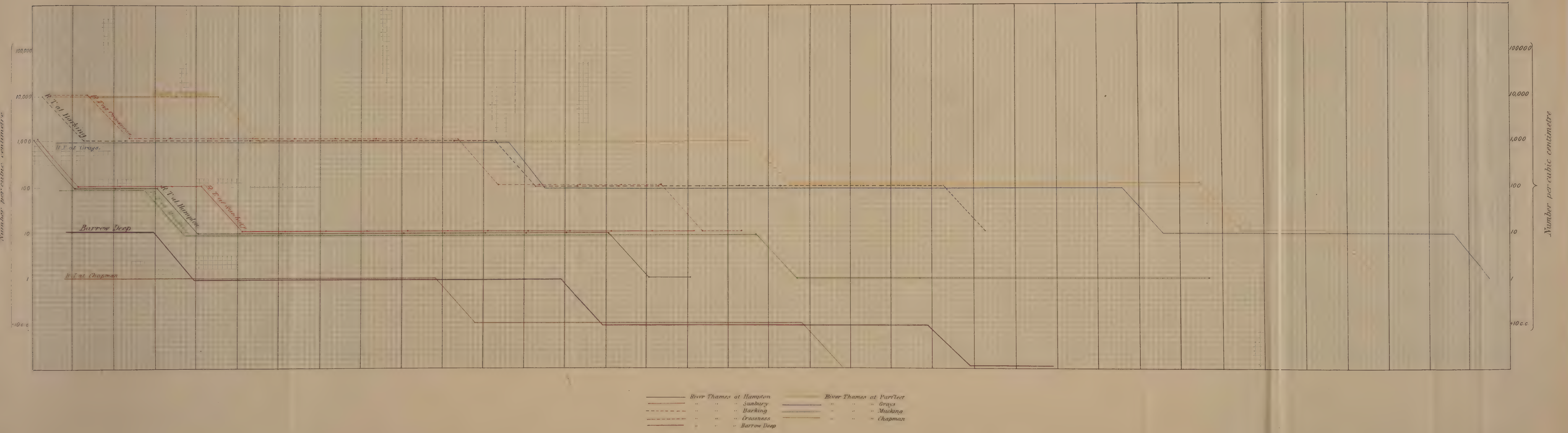

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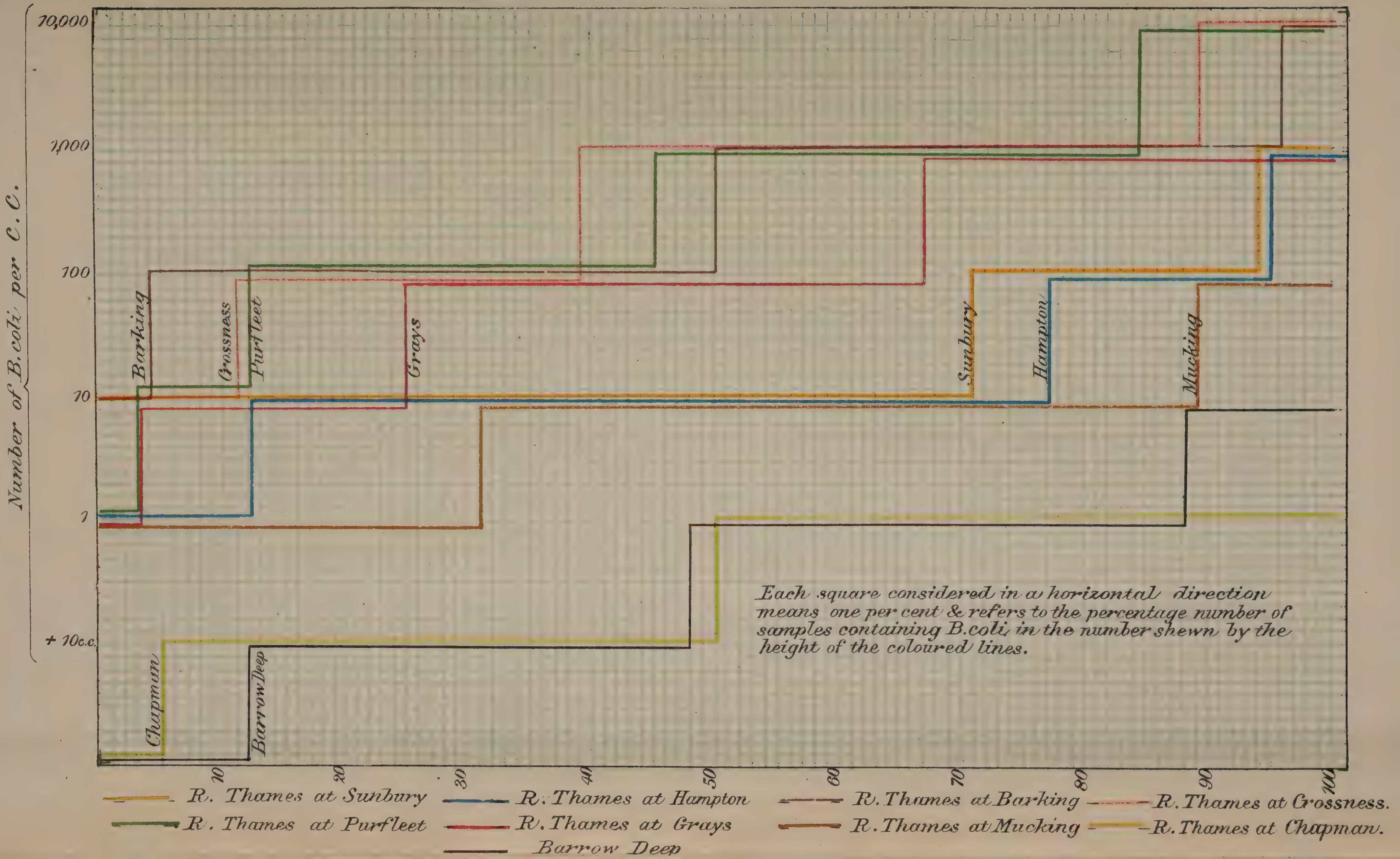
Diagram 20 showing the percentage number of samples out of the total number examined in each case containing B.coli (or allied forms) in the number shewn below.



Each square considered in a horizontal direction means one per cent & refers to the percentage number of samples containing B.coli in the number shewn by the height of the coloured lines.

Diagram 21 showing the percentage number of samples out of the total number examined in each case containing B. coli (or allied forms) in the number specified below.

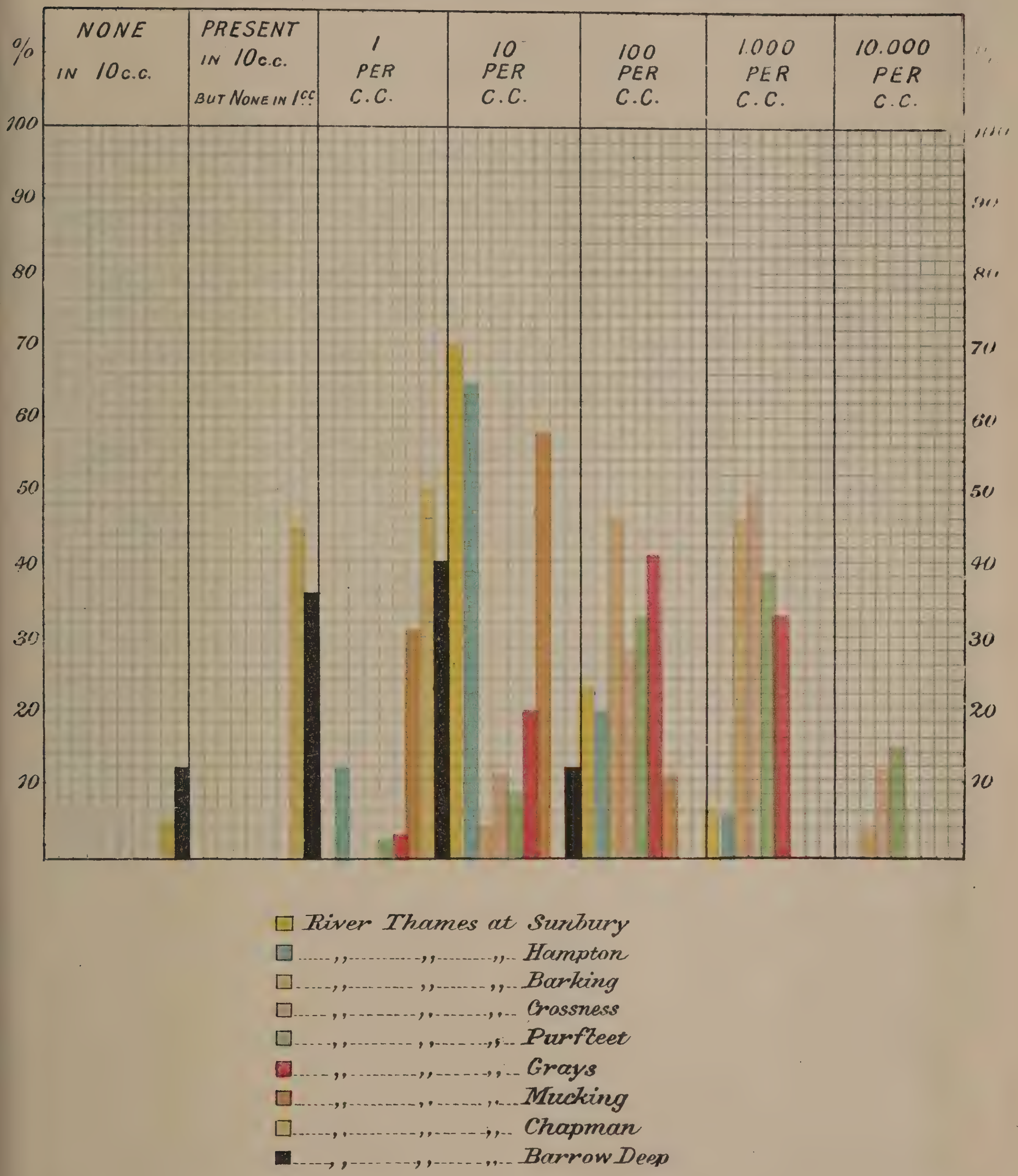


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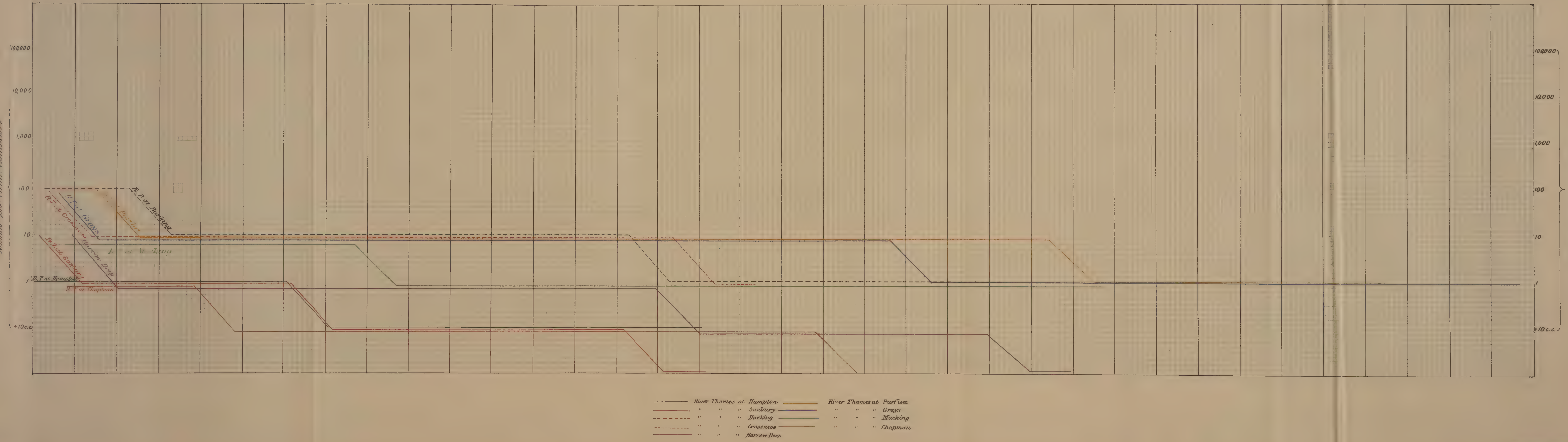
Diagram 22 showing, as regards the B. Enteritidis sporogenes test, the results of the Bacteriological Examination of the River Thames at Hampton, Crossness, Purfleet, Gray, Mucking & Chapman & of the sea water in Barrow Deep.



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Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Last, I think, comes the Chapman, with a positive result in 1 c.c. in only about every fourth sample.

The waters may be arranged in order as follows :—

River Thames at :—	*Spores of B. enteritidis sporogenes per c.c. :—*
Crossness Purfleet Barking Grays	Usually 1 to 10, but more often 10 than 1.
Mucking	1 to 10, but more often 1 than 10.
Barrow Deep	1 per 10 c.c. to 1 per 1 c.c., but most often the latter.
Sunbury Hampton	1 per 10 c.c. to 1 per 1 c.c., but rather more often 1 per 10 c.c.
Chapman	Positive result with 1 c.c. only in about every fourth sample.

The number of samples from the different places was not always the same, so Table 16 and Diagram 23 are given which, by a percentage method of classification, renders their comparison a simple matter.

TABLE 16, showing the percentage number of samples out of the total number examined in each case containing spores of B. enteritidis sporogenes in the number specified below.

River Thames at.	Percentage number of samples out of the total number examined in each case containing B. enteritidis sporogenes in the number specified below.						Total number of samples examined.
	− 10 c.c.	+ 10 c.c. − 1 c.c.	+ 1 c.c. − ·1 c.c.	+ ·1 c.c. − ·01 c.c.	+ ·01 c.c. − ·001 c.c.	+ ·001 c.c. − ·0001 c.c.	
	None in 10 c.c.	Present in 10 c.c. but less than 1 per c.c.	At least 1 per c c.	At least 10 per c.c.	At least 100 per c.c.	At least 1,000 per c.c.	
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	
Sunbury	12·5	43·7	37·5	6·2			16
Hampton		58·8	41·1				17
Barking			37	50	12		24
Crossness			11·1	83·3	5·5		18
Purfleet			24·2	69·7	6		33
Grays			41·6	55·5	2·7		36
Mucking			69·2	30·7			26
Chapman	5	75	20				20
Barrow Deep*	8	32	56	4			25

* In one case no 10 c.c. cultures were made, but the result was negative in 1 c.c. This has been classed as +10 c.c., −1c.c.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

CONCLUSIONS.

I. The water of the River Thames at Sunbury and Hampton, above the intakes of some of the London Water Companies, is so far unsatisfactory *from the bacteriological point of view* as almost to justify its description as extremely dilute sewage; as, for instance, sewage diluted 1,000 to 10,000 times.

II. The Barking (Northern outfall) and Crossness (Southern outfall) "chemically produced" effluents resemble in their biological composition raw sewage; they contain about 100,000 coli-like microbes and about 100 to 1,000 spores of B. enteritidis sporogenes respectively per c.c. During 1902 the combined volume of effluent from the Barking and Crossness works amounted to a daily average of 232 million gallons.

III. The bacteriological condition of the River Thames at Barking, Crossness, and Purfleet is very unsatisfactory.

Crossness is about two miles below Barking, and Purfleet about five miles below Crossness. Speaking in general terms, the water at these places contained about 100 to 1,000 coli-like microbes, and usually 1 to 10 spores (but more often 10 than 1 spore) of B. enteritidis sporogenes, per c.c.

IV. At Grays, about five miles lower down the river than Purfleet, the water showed some slight evidence of improvement, particularly as regards the B. coli test.

V. At Mucking, about 10 miles below Grays, the Thames water shows definite signs of improvement.

With regard to coli-like microbes, 11·5 per cent. of the samples contained 100, 57·7 per cent. contained 10, and 30·8 per cent. contained 1, per c.c.

As regards B. enteritidis sporogenes, about one-third of the samples contained 10 spores and about two-thirds 1 spore per c.c.

Judged on this basis, therefore, the water at this point was, as regards the B. coli test, purer, and in respect of the B. enteritidis sporogenes test somewhat less pure, than the water in the upper reaches of the river at Sunbury and Hampton.

Apart from its chemical composition, and considered only in reference to bacteriological results, the water at Mucking was seemingly as fit for filtration and water-works purposes as at Sunbury and Hampton.

VI. At the Chapman Lighthouse, five miles below Mucking, the Thames water was so far improved relatively, as seemingly to vie in biological purity (*qua* B. coli) with some of the samples of filtered London water. About half the samples contained less than 1 coli-like microbe per c.c.

As regards the B. enteritidis sporogenes test, about, four-fifths of the samples from this section of the river gave a positive result with 10 c.c. but a negative result with 1 c.c.

The alleged *gross* pollution of the Essex and Kent foreshores eastwards of a line connecting the Chapman Lighthouse with Stoke, as a result of the discharge of the Barking and Crossness effluents into the Thames, would thus appear from these data to be without sufficient warrant.

VII. The water obtained from the Barrow Deep was found to be, under the circumstances, remarkably satisfactory, notwithstanding the fact that 50,000 tons of sludge containing usually, according to results of the bacteriological examination from 1,000,000 to 10,000,000,000 coli-like microbes per c.c., and from 10,000 to 100,000 spores of B. enteritidis sporogenes per c.c., were being deposited weekly in the Barrow Deep.

As regards coli-like microbes, the water here usually contained either 1 in 10 c.c. or 1 in 1 c.c. About half the samples contained spores of B. enteritidis sporogenes in 1 c.c., while about a third yielded a positive result with 10 c.c. but a negative result with 1 c.c. Broadly speaking, therefore, the Chapman and Barrow Deep results did not differ greatly as regards coli-like microbes.

The B. enteritidis sporogenes test, however, yielded somewhat less satisfactory results at Barrow Deep than at the Chapman Lighthouse.

It follows, therefore, that the alleged *serious* pollution of the Thames Estuary, as a result of the deposit of sludge by the London County Council in the Barrow Deep, is not supported by the results of the bacteriological analyses.

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VIII. It is a point worthy of notice that, whereas at Barking, Crossness, Purfleet, and Grays, coli-like microbes were much more numerous than spores of B. enteritidis sporogenes; lower down the river the B. enteritidis sporogenes curve actually encroached on and in some instances overstepped the B. coli curve.

These results probably indicate that the decline in excremental bacteria in the lower reaches of the river is due not solely to sedimentation and dilution, but also *qua* non-sporing forms, *e.g.*, coli-like microbes to destruction and death of these bacillary bodies.*

IX. As regards the filtered London (*main*) water (Southwark and Vauxhall and East London Water Companies) it is undesirable to speak definitely. But allowing for the atypical characters of many of the coli-like microbes isolated from the samples tested, and even assuming that, owing to the abnormally unfavourable meteorological condition prevailing during the period of observation, the filtered water was then at its worst, the seemingly unsatisfactory bacteriological results recorded (*qua* these potable waters) afford food for reflection. Nor need the fact be ignored that from the critical point of view the results indicate that, before coming to other than tentative conclusions as regards shell-fish, shell-fish layings, and the water surrounding these layings, more extended knowledge is required of the number and characters of the coli-like microbes present in many other of our public water supplies in relation to presence and absence of epidemic disease among the consumers of these waters.†

While fully admitting the importance of these and other practical considerations, the bacteriological outlook *in futuro* is not, I think, devoid of promise.

At present, of course, there would seem to be no justification for the wholesale condemnation of potable waters, or of sea water, or of estuarial waters, or of shell-fish, owing to the mere presence of coli-like microbes, irrespective of their relative abundance. Further, it would seem unjust to raise even tentative objections as regards impurity, unless the number and characters of the coli-like microbes present in the material under examination is definitely determined; it being, of course, necessary that the microbes in question should be isolated in *pure* culture and an accurate account furnished of their biological characters, so that the results and conclusions may withstand intelligent comparative scrutiny. But given complete and detailed statement of facts, along with examination both qualitatively and quantitatively of a plurality of samples of material, the judgment of the bacteriologist, controlled or modified, if need be, by topographical observations and epidemiological considerations, may be of real and present practical value.‡

X. Finally, and taking a broad and common-sense view of the whole investigation, the following general inferences are perhaps warranted:

(a) That a water which, from the bacteriologist's point of view, would be considered very impure, *may* after filtration, although still containing an appreciable number of bacteria seemingly of intestinal derivation, be used for domestic purposes without any very definite or detectable harm resulting.

---

* If this assumption be correct, and the presumptive evidence is in favour of it, the interpretation, set forth in my past Reports to the Local Government Board, of the value and of the inter-relation of these two tests in gauging respectively recent and past excremental pollution, receives confirmation.

† It must, of course, be remembered that flood water during the months of May and June may be of less significance than during the later and the earlier months of the year, owing to the greater prevalence of enteric fever in the autumn and early winter.

‡ In Appendix C extracts are given from the Government Analyst's report on the Metropolitan water supply during May and June, 1903.

The following passage may be quoted:—"The Southwark was the first to fall off in quality, and on the 19th June the 'oxygen consumed' figure reached ·512 part per 100,000, and probably represented an amount of total organic impurity that has not been exceeded in a London water during the last 34 years."

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[This statement in no way implies that in the opinion of the writer (who holds rather the contrary view) impure waters, even after careful filtration, are necessarily uniformily safe for potable purposes. The question, however, to be dealt with here concerns the facts elicited during the period of observation. From this point of view, the results seem to indicate the danger of hastily condemning waters and other materials without a wider knowledge of comparative bacteriology, and of the correlation of bacteriology and epidemiology than is at present available.]

(b) That the water of a tidal river grossly polluted in its lower estuarial reaches may after a flow of some 25 miles become so far purified by sedimentation, dilution, and the operation presumably of bactericidal agencies, as to become seemingly as little objectionable, or in some respects less objectionable, bacteriologically than certain of our public water supplies.

(c) That the deposition in the sea, of chemically precipitated sludge in enormous quantities if carried out under proper conditions, need not result necessarily in the production of nuisance or serious pollution of the surrounding water, and that such deposition may be thought of as an economical and seemingly not unsatisfactory means of disposing of this material.

APPENDIX A.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Giving the Details of the Conditions under which the Samples were Collected from the Barrow Deep.

Details of samples taken on February 24th, 1903, for Royal Commission on Sewage Disposal :—

s.s. " Barrow " finished discharging the last cargo of the previous tide at 4.5 a.m. ; position No. 3 buoy, mid-channel ; state of tide, nearly low water.

Sample from first boat, No. 1 A : s.s. " Barking " time sample taken, 2.30 p.m. ; position, No. 6 buoy ; state of tide, about ¾ ebb.

Intermediate boats : s.s. " Bazalgette," commenced 2.40 p.m , finished discharging 3 p.m. ; s.s. " Barrow," commenced 3.50 p.m., finished discharging 4.20 p.m. ; s.s. " Binnie," commenced 4.10 p.m., finished discharging 4.20 p.m.

Sample from last boat, No. 1 B : s.s. " Belvedere," time sample taken, 4.25 a.m. ; position, No. 3, mid-channel ; state of tide, nearly low water.

Samples are taken from bows of sampling vessels before they commence to discharge.

Robert G. Warrick, Marine Supt.

Details of samples taken on March 3rd, 1903, for Royal Commission on Sewage Disposal :—

s.s. " Burns " finished discharging the last cargo of the previous tide at 8.45 p.m., March 2nd, 1903 ; position, No. 1 buoy ; state of tide, nearly low water.

Sample from first boat, No. 2 A : s.s. " Belvedere," time sample taken 6.15 a.m., March 3rd, 1903 ; position, No. 3 buoy ; state of tide, about ¾ ebb.

Intermediate boats : s.s. " Barking," commenced 7.5 a.m., finished discharging 7.15 a.m. ; s.s. " Burns," commencing 6.45 a.m., finished discharging 7.35 a.m. ; s.s. " Bazalgette," commencing 7.10 a.m., finished discharging 7.40 a.m.

Sample from last boat, No. 2 B : s.s. " Binnie," time sample taken, 8.15 a.m., March 3rd, 1903 ; position, No. 6 buoy ; state of tide, a little before low water.

Samples are taken from bows of sampling vessels before they commence to discharge.

Robert G. Warrick, Marine Supt.

Details of samples taken on March 10th, 1903, for Royal Commission on Sewage Disposal :—

s.s. " Binnie " finished discharging the last cargo of the previous tide at 2.25 a.m. ; position, No. 3 buoy ; state of tide, last hour of ebb.

Sample from first boat, No. 3 A : s.s. " Burns," time sample taken, noon ; position No. 10 buoy ; state of tide, half ebb.

Intermediate boats : s.s. " Belvedere," commenced 1.40 p.m., finished discharging 1.50 p.m. ; s.s. " Bazalgette," commenced 1.55 p.m., finished discharging 2.20 p.m. ; s.s. " Barrow," commenced 1.35, finished discharging 2 p.m.

Sample from last boat, No. 3 B. : s.s. " Binnie," time sample taken, 3.50 p.m. ; position, No. 6 buoy ; state of tide, last quarter ebb.

Samples are taken from bows of sampling vessels before they commence to discharge.

Robert G. Warrick, Marine Supt.

Details of samples taken on March 17th, 1903, for Royal Commission on Sewage Disposal :—

s.s. " Burns " finished discharging the last cargo of the previous tide at 8.50 a.m. ; position No. 1 buoy ; state of tide, low water.

Sample from first boat, No. 4 A : s.s. " Barrow," time sample taken, 6.50 a.m. ; position No. 6 buoy ; state of tide, about two hours before low water.

Intermediate boats : s.s. " Belvedere," commenced 6.55 a.m., finished discharging 7.5 a.m. ; s.s. " Bazalgette" commenced 7.55 a.m., finished discharging 8.25 a.m. ; s.s. " Binnie," commenced 8.30, finished discharging 8.50 a.m.

Sample from last boat, No. 4 B : s.s. " Burns," time sample taken, 9 a.m. ; position, No. 10 buoy ; state of tide, low water.

Samples are taken from bows of sampling vessels before they commence to discharge.

Robert G. Warrick, Marine Supt.

Details of samples taken on March 24th, 1903, for Royal Commission on Sewage Disposal :—

s.s. " Burns " finished discharging the last cargo of the previous tide at 2.40 a.m. ; position, No. 1 buoy ; state of tide, low water.

Sample from first boat, No. 5 A : s.s. " Bazalgette," time sample taken, 0.54 p.m. ; position, No. 5 buoy ; state of tide, ⅔ ebb.

Intermediate boats : s.s. " Barrow," commenced 1.30 p.m., finished discharging 1.45 p.m. ; s.s. " Belvedere," commenced 1.45 p.m., finished discharging 2 p.m.

Sample from last boat, No. 5 B : s.s. " Burns," time sample taken, 1.56 p.m. ; position, No. 10 ; state of tide, last of ebb.

Samples are taken from bows of sampling vessels before they commence to discharge.

Robert G. Warrick, Marine Supt.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Details of samples taken on March 25th, 1903, for Royal Commission on Sewage Disposal:

The following samples were collected ~~by the wr~~iter from the s.s. "Burns," during his inspection of the condition of the Barrow Deeps and the method adopted by the London County Council of discharging the sludge into the sea, on March 25th, 1903:—

(1) *Barrow Deeps.*—No. 10 buoy, outward journey before discharge.
(2) ,, ,, Between Nos. 10 and 6 buoys, average sample collected every two minutes. Outward journey.
(3) ,, ,, Between Nos. 6 and No. 4 buoys, average sample collected every two minutes. Outward journey.
(4) ,, ,, Between Nos. 4 and No. 2 buoys, average sample every two minutes. Outward journey.
(5) ,, ,, Below No. 2 buoy, taken while steamer circling round for return journey.
(6) ,, ,, Between No. 2 and No. 6 buoys, average sample collected every two minutes. Return journey.
(7) ,, ,, Between Nos. 6 and No. 10 buoys, average sample collected every two minutes. Return journey.
(8) ,, ,, No. 10 buoy. Return journey.

Samples 1 and 8 were mixed together (equal parts) before analysis.
Samples 2, 3, and 4 were mixed together (equal parts) before analysis.
Samples 5 examined separately.
Samples 6 and 7 were mixed together (equal parts) before analysis.

The condition of the water in the Barrow Deep appeared to be satisfactory, and the process of discharging the sludge unattended with obvious nuisance. A favourable opinion was formed of the method adopted under the circumstances.

A. C. H.

March 25th, 1903.

Details of samples taken on March 31st, 1903, for Royal Commission on Sewage Disposal:—

s.s. "Burns" finished discharging the last cargo of the previous tide at about 9.30 p.m., March 30th, 1903; position, No. 3; state of tide, nearly low water.

Sample from second boat, No. 6 A: s.s. "Belvedere," time sample taken, every two minutes from 5.55 to 6.30 a.m.; position, from No. 10 to No. 1 buoys"; state of tide, about two-thirds ebb.

Intermediate boats: s.s. "Barrow," commenced 7.15 a.m., finished discharging 7.35 a.m.; s.s. "Bazalgette," commenced 7.45 a.m., finished discharging 8.15 a.m.

Sample from last boat, No. 6 B: s.s. "Burns," time sample taken, every two minutes from 9.30 to 10.15 a.m.; position, from No. 1 to No. 10 buoys; state of tide, low water.

Samples are taken from bows of sampling vessels.

Robert G. Warrick, Marine Supt.

Details of samples taken on April 1st, 1903, for Royal Commission on Sewage Disposal:—

s.s. "Burns" finished discharging the last cargo of the previous tide at 6.10 p.m., March 31st, 1903; position, No. 1 buoy; state of tide, last quarter ebb.

Sample from first boat, No. 7 A: April 1st, 1903: s.s. "Barking," time sample taken, every two minutes from 5.26 to 6.13 a.m.; position, from No. 10 to No. 2 buoys; state of tide, last quarter ebb.

Intermediate boats: s.s. "Belvedere," commenced 6.10 a.m., finished discharging 6.20 a.m.; s.s. "Bazalgette, commenced 6.40 a.m., finished discharging 7.10 a.m.; s.s. "Barrow," commenced 6.55 a.m., finished discharging 7.15 a.m.; s.s. "Burns," commenced 7 a.m., finished discharging 7.40 a.m.

Sample from last boat, No. 7 B: s.s. "Barking," time sample taken, every two minutes from 7.40 to 8.30 a.m.; position, No. 1 to No. 10 buoys; state of tide, nearly low water.

Samples are taken from bows of sampling vessels.

Robert G. Warrick, Marine Supt.

Details of samples taken on April 7th and 8th, 1903, for Royal Commission on Sewage Disposal:—

s.s. "Barrow" finished discharging the last cargo of the previous tide on 2.10 p.m., April 7th, 1903; position, No. 1 buoy; state of tide, nearly low water.

Sample from first boat, No. 8 A: s.s. "Binnie," time samples taken, every two minutes from 11.10 to 11.30 p.m.; position, from No. 10 to No. 3 buoys; state of tide, about half ebb.

Intermediate boats: s.s. "Burns," commenced 11.35 p.m., finished discharging midnight, April 7th, 1903; s.s. "Bazalgette," commenced 0.20 a.m., finished discharging 0.40 a.m., April 8th, 1903; s.s. "Belvedere," commenced 0.50 a.m., finished discharging 1.10 a.m., April 8th, 1903; s.s. "Barking," commenced 2 a.m., finished discharging 2.30 a.m., April 8th, 1903.

Sample from last boat, No. 8 B: s.s. "Barrow," time samples taken, every two minutes from 2.25 to 3.25 a.m., April 8th, 1903; positions, from No. 1 to No. 10 buoys; state of tide, nearly low water.

Samples are taken from bows of sampling vessels.

Robert G. Warrick, Marine Supt.

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Bacteriological Examination of the River Thames and Thames Estuary.

Details of samples taken on April 15th, 1903, for Royal Commission on Sewage Disposal :—

Sludge ships finished discharging their last cargoes on Saturday afternoon, April 11th.

Sample from first boat, No. 9 A : s.s. "Barrow," time sample taken, 6.45 p.m., April 15th, 1903 ; position, No 3 ; state of tide, two-thirds ebb.

Intermediate boats : s.s. "Barking," commenced ~~6.50,~~ finished discharging 7.5 p.m. ; s.s. "Belvedere," commenced 6.50, finished discharging 7.5 p.m. ; s.s. "Bazalgette," commenced 7.25, finished discharging 7.45 p.m. ; s.s. "Burns," commenced 7.10, finished discharging 7.45 p.m.

Sample from last boat, No. 9 B : s.s. "Binnie," times sample taken, from No. 3 to No. 10 buoys, every two minutes, from 8 to 8.30 p.m. ; state of tide, last quarter ebb.

Samples are taken from bows of sampling vessels.

Robert G. Warrick, Marine Supt.

Details of samples taken on April 21st, 1903, for Royal Commission on Sewage Disposal :—

s.s. "Barrow" finished discharging the last cargo of the previous tide at about 1.30 p.m., April 20th, 1903 ; position, No. 3 buoy ; state of tide, first quarter flood.

Sample from first boat, No. 10 A : s.s. "Binnie," times sample taken, every two minutes from 10.40 to 11.10 p.m., April 20th, 1903 ; position, between Nos. 3 and 8 buoys ; state of tide, last quarter ebb.

Intermediate boats : s.s. "Barking," commenced 11.20 p.m., finished discharging 11.35 p.m., April 20th, 1903 ; s.s. "Burns," commenced 11.25 p.m., finished discharging midnight, April 20th, 1903 ; s.s. "Bazalgette," commenced 0.45 a.m., finished discharging 1.5 a.m., April 21st, 1903.

Sample from last boat, No. 10 B : s.s. "Barrow," times sample taken, every two minutes from 1.50 a.m. to 2.5 a.m., April 21st, 1903 ; position, from Nos. 3 and No. 1 buoys ; state of tide, after low water.

Samples are taken from bows of sampling vessels.

Robert G. Warrick, Marine Supt.

Details of samples taken on April 22nd, 1903, for Royal Commission on Sewage Disposal :—

s.s. "Barrow" finished discharging the last cargo of the previous tide at 2.35 p.m., April 21st, 1903 ; position, No. 1 buoy ; state of tide, first quarter flood.

Sample from first boat., No. 11 A : s.s. "Binnie," time sample taken, every two minutes from 10.50 to 11.20 p.m., April 21st, 1903 ; position, from No. 10 to No. 6 buoys ; state of tide, last quarter ebb.

Intermediate boats : s.s. "Bazalgette," commenced 11.50 p.m., April 21st, 1903, finished discharging 0.10 a.m., April 22nd, 1903 ; s.s. "Burns," commenced 11.50 a.m., April 21st, 1903, finished discharging 0.10 a.m., April 22nd, 1903. ; s.s. "Barking," commenced 11.50 a.m., April 21st, 1903, finished discharging 6.10 a.m., April 22nd, 1903.

Sample from last boat, No. 11 B : s.s. "Barrow," times sample taken, every two minutes from 2.30 to 3.10 a.m., April 22nd, 1903 ; position, from No. 1 to No. 10 buoys ; state of tide, first quarter flood.

Samples are taken from bows of sampling vessels.

Robert G. Warrick, Marine Supt.

Details of samples taken on April 23rd, 1903, for Royal Commission on Sewage Disposal :—

s.s. "Barrow" finished discharging the last cargo of the previous tide at 2.15 p.m., April 22nd, 1903 ; position, No. 1 buoy ; state of tide, low water.

Sample from first boat, No. 12 A : s.s. "Binnie," times sample taken, every two minutes from 11.30 p.m. to midnight, April 22nd, 1903 ; position, from No. 10 to No. 1 buoys ; state of tide half ebb.

Intermediate boats ; s.s. "Bazalgette," commenced 0.20 a.m., finished discharging 0.45 a.m., April 23rd, 1903 ; s.s. "Barking," commenced 0.30 a.m., finished discharging 0.45 a.m., April 23rd, 1903 ; s.s. "Burns," commenced 0.45 a.m., finished discharging 1.20 a.m., April 23rd, 1903.

Sample from last boat, No. 12 B : s.s. "Barrow," times sample taken every two minutes from 2.20 to 2.55 a.m., April 23rd, 1903 ; position, from No. 1 to No. 10 buoys ; state of tide, lo water.

Samples are taken from bows of sampling vessels.

Robert G. Warrick, Marine Supt.

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Bacteriological Examination of the River Thames and Thames Estuary.

APPENDIX B.

Daily Rainfall for the earlier half of the year 1903.

Compiled from Meteorological Observations taken at the Royal Observatory at Greenwich and published in the Registrar General's Weekly Returns.

(Rain collected in a gauge whose receiving surface is 5 inches above the ground.)

1903.

Day.	January.	February.	March.	April.	May.	June.
	in.	in.	in.	in.	in.	in.
1	0·00	0·20	0·17	0·16	0·05	0·00
2	0·14	0·00	0·30	0·07	0·00	0·00
3	0·09	0·00	0·02	0·00	0·34	0·00
4	0·27	0·00	0·00	0·16	0·05	0·00
5	0·59	0·00	0·18	0·00	0·03	0·00
6	0·04	0·00	0·00	0·00	0·07	0·00
7	0·00	0·02	0·19	0·00	0·15	0·00
8	0·03	0·00	0·00	0·03	0·02	0·00
9	0·02	0·00	0·08	0·00	0·13	0·57
10	0·00	0·00	0·09	0·00	0·00	0·75
11	0·00	0·00	0·00	0·00	0·12	0·44
12	0·00	0·00	0·00	0·00	0·02	0·00
13	0·00	0·00	0·00	0·01	0·00	0·58
14	0·00	0·00	0·00	0·00	0·00	0·98
15	0·00	0·01	0·00	0·04	0·00	1·32
16	0·00	0·00	0·00	0·00	0·17	0·30
17	0·21	0·00	0·03	0·00	0·3	0·31
18	0·10	0·00	0·09	0·00	0·00	0·00
19	0·07	0·00	0·05	0·00	0·00	0·81
20	0·02	0·00	0·00	0·00	0·00	0·01
21	0·00	0·00	0·00	0·00	0·00	0·00
22	0·10	0·02	0·00	0·00	0·01	0·00
23	0·01	0·17	0·17	0·00	0·00	0·00
24	0·06	0·03	0·04	0·00	0·00	0·00
25	0·01	0·18	0·03	0·00	0·00	0·00
26	0·00	0·17	0·06	0·53	0·00	0·00
27	0·23	0·17	0·17	0·18	0·00	0·00
28	0·10	0·39	0·13	0·11	0·33	0·00
29	0·00	—	0·04	0·32	0·00	0·00
30	0·00	—	0·38	0·23	0·00	0·00
31	0·03	—	0·00	—	0·13	—

APPENDIX C.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

Extracts from the Government Analyst's Report on the Metropolitan Water Supply during May and June, 1903.

The Government analyst, in his official report on the samples of the Metropolitan water supply examined during May, 1903, states in his report, among other observations, that:—

"The supplies of the five companies distributing filtered Thames water contained more organic matters than in April, the increase in impurities being due to the floods which occurred early in the month (May)" . . . .

> "The East London water taken on the 8th (May) was derived from the company's Thames and Hanworth sources, and was inferior in quality to that distributed in the previous month (April); . . . . from the high proportion of nitric nitrogen it was evident that the mixed supply contained a much larger proportion of the Hanworth gravel water than usual."

Seen through a stratum two feet deep, the colour of the Southwark water and of the East London water is described as "very pale yellow" (18th May), and the East London water as "yellow" (8th May).

The supplies of the companies dealing with Thames water were at the end of April, it is stated,—

> "Freer from organic impurities than they had been since the beginning of the year, but the heavy flood which occurred in the early part of May seriously affected the condition of the river, and consequently the companies which possess comparatively little storage were for some days unable to avoid the distribution of water of very unsatisfactory quality."

It is also stated that the quality of the Southwark Company's water "was only slightly disturbed" by these abnormal conditions. With regard to the East London Company's supply, it is also pointed out in the Report that "on a few dates (May 6th, 8th, and 11th) the water, delivered in districts supplied from the Thames and Hanworth sources of the company, was of somewhat indifferent quality." It is also noted that among others, the Southwark Company's water was found to contain—

> "On several occasions small amounts of suspended matters, consisting chiefly of rust-stained particles, and probably derived from the mains. In addition to the particles of rust, the Southwark Company's water often contained diatoms and other organisms."

The Report for the month of June states that the Southwark Company's water taken on the 15th June "contained less organic matter than in May," and was "of fair quality."

> "The water drawn from the mains of the Southwark Company (and some other companies) on the 23rd of June was of very unsatisfactory quality, owing to its deep brown colour and the excessive amount of organic impurity which it contained; the Southwark Company's water was by far the worst, and from a search through the analytical records it appears that not since February, 1869, has such a large amount of organic impurity been observed in a filtered London water. The great increase in organic impurity has, of course, been due to the large volumes of land water which immediately drained into the Thames, owing to the very heavy rains of the past month (June), and it is evident from the very high ratio of carbon to nitrogen (13 : 1) that the organic matters washed into the river were mainly of a vegetable character. One effect of the extraordinary rain was to reduce the proportion of chlorides in the filtered Thames water; the amount of chloride, which at this time of year is usually 1·6 or 1·7, fell, in the case of the Southwark supply, on the 23rd (June) to 1·25 pts. per 100,000. The Southwark Company's water on the 23rd June was very slightly turbid."

* * * * * *

> "The East London Company's filtered water, collected on 15th June, was drawn in a district supplied with water from the Thames at Sunbury and wells at Hanworth; it was clear and of fair quality."

It is also noteworthy that the Southwark Company's water was on 23rd June described as "dark brown in colour."

> "From a detailed consideration of the above results and those obtained in May, it appears that all the Thames-derived waters had at the commencement of the past month practically recovered from the effect of the May flood, and the proportions of organic matters in the several supplies were approaching those usually found in summer months. The quality of all the Thames waters remained good until about the middle of the month, when the floods, consequent on the exceptional rainfall, rendered the condition of the river unfavourable for the operations of the Companies, and those possessing but little storage were, as usual at such time, unable to avoid the distribution of water of very high colour and considerable organic contamination. The Chelsea and West Middlesex Companies' supplies were but little affected until nearly the end of the month, and even then the maximum amounts of organic impurities present were less than half those reached in the cases of the Southwark and Grand Junction waters. The Southwark water was the first to fall off in quality, and on the 19th June the "oxygen consumed" figure reached ·512 part per 100,000, and probably represented an amount of total organic impurity which has not been exceeded in a London water during the last 34 years. Notwithstanding the floods which took place in May, the Southwark Company made such good use of stored water that the quality of the supply was the best of the Thames waters in May, and it

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Bacteriological Examination of the River Thames and Thames Estuary.

would seem, from the unfortunate circumstance that the June floods followed so soon after those of May, that the Southwark Company was unable to recharge its storage reservoirs in time, and was consequently unable to avoid passing the flood water direct to the filters during the past month. The quality of the Southwark Company's water from the 19th to the end of the month was bad, and the supplies of the Grand Junction and Lambeth Companies from the 22nd to the end of the month were also of unsatisfactory quality. The experience of the last month clearly indicates that the present storage arrangements of certain of the Companies are inadequate to cope with the condition of things which prevailed during the heavy rains of June.

"The New River Company's water, although it contained on a few occasions more organic impurity than usual, was of good quality throughout the month.

"The East London Company's supply contained, on the average, about the same proportion of organic matter as the West Middlesex Company's water, and all the samples examined were of good quality, except one taken on the 24th June.

"The Kent Company's deep-well supply maintained its usual excellent quality throughout the month.

"All the samples of the West Middlesex, New River, and Kent Companies' supplies were clear, but in the cases of the other Companies' waters, on a few occasions and many times in the case of the Southwark, small amounts of suspended matters, chiefly inorganic, were observed. The Southwark water on the 19th June was opalescent, and indicated that at the time the Company's filters were unable to entirely remove the fine particles of clay from the flood water with which they were charged."

APPENDIX D.

Division I.

Bacteriological Examination of the River Thames and Thames Estuary.

MEMORANDUM GIVING INFORMATION ASKED FOR BY THE SECRETARY OF THE ROYAL COMMISSION ON SEWAGE DISPOSAL, IN LETTER DATED THE 28TH JULY, 1903.

(*a*) *Question.*—The discharge of the River Thames at a point about midway between Sunbury and Hampton ?

Answer.—The *natural* flow for 20 years (1883–1902) may be taken as ranging from a maximum of 2,149¾ million gallons per day in February, to a minimum of 429¾ million gallons per day in August.

The natural daily flow as averaged over 20 years (1883–1902) is 1,110½ million gallons.

From the *natural* flow the amount subtracted by the water companies ought to be deducted to obtain the net flow. The average daily amount subtracted by the water companies during 1902 was 133½ million gallons ; the above figures would then become——

Maximum	..	2,149¾ − 133½ = 2,016¼	million gallons per day.
Minimum	..	429¾ − 133½ = 296¼	million gallons per day.
Average daily	..	1,110½ − 133½ = 977	million gallons per day.

(*b*) *Question.*—The discharge of the Thames (high and low tides) at a point about midway between Barking and Crossness ?

Answer.—I have not been able to make observations to answer exactly, but a number of figures with reference to this question were placed before the Royal Commission on Metropolitan Sewage Discharge in 1882. From careful experiments made by Mr. Henry Law it was found that the amount of water passing Barking or Crossness in one average ebb tide of seven hours was 16,156 million gallons.

(*c*) *Question.*—The normal *dry weather* flow of the effluent at Barking and Crossness ?

Answer.—At Barking 120 million gallons per day ; at Crossness, 80 million gallons per day.

(*e*) *Question.*—The volume of sludge discharged into the Barrow Deep ?

Answer.—The average discharge per tide during 1902 was 128,556 cubic feet, or 257,112 cubic feet per day. Ninety-two per cent. of the sludge is water. The actual *daily* weight of solid matter discharged in the Barrow Deep was 558 tons.

(*f*) *Question.*—The estimated ratio between the volume of sludge and the volume of high and low tide of the water in the stretch of the Barrow Deep traversed by the sludge steamers during their discharge ?

Answer.—(1) *At high water of ordinary spring tides* the volume of water in the Barrow Deep is 35,040,960,000 cubic feet, the volume of sludge discharged each tide is 128,556 cubic feet : ∴ ratio = $\frac{128556}{35040960000}$ = 1 to 280,000 (about).

(2) *At mean tide level.*—Volume of water in Barrow Deep, 30,072,000,000 cubic feet : ∴ ratio = $\frac{128556}{30072000000}$ = 1 to 234,000 (about).

(3) *At low water of ordinary spring tides.*—Volume of water in Barrow Deep 21,106,500,000 cubic feet : ∴ ratio = $\frac{128556}{25156500000}$ = 1 to 197,000 (about).

Note.—The above figures for the water in the Barrow Deep give the actual volume of water in the Deep at any one time. It must be remembered of the above figures for sludge 92 per cent. is water.

MAURICE FITZMAURICE.

23rd November, 1903.

DIVISION II.

THE INOCULATION OF SEWAGE WITH B. PYOCYANEUS AND THE SUBSEQUENT ISOLATION OF THIS MICROBE FROM (1 A) THE EFFLUENT FROM A CONTINUOUS FILTER; (2 A) SEPTIC TANK LIQUOR; AND (2 B) THE EFFLUENT FROM CONTACT BEDS.

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Division II.

Passage of B. pyocyaneus through a continuous filter bed an through a septic tank and contact beds.

The inoculation of sewage with B. pyocyaneus and the subsequent isolation of this microbe from (1*a*) *the effluent from a continuous filter ;* (2*a*) *septic tank liquor ; and* (2*b*) *the effluent from contact beds.*

The records obtained since 1898 of the biological qualities of the effluents from septic tank and bacteria bed processes of sewage treatment may seem to render this special enquiry almost unnecessary. Thus it has been shown by carefully conducted quantitative experiments that in their intrinsic biological qualities the effluents from artificial processes of sewage treatment differ so slightly from raw sewage as to be almost as potentially dangerous to health as the sewage antecedent to its treatment. Nevertheless, the results obtained by the use of the quantitative biological tests above referred to afford strong presumptive evidence, rather than absolute proof, of the pathogenic qualities of sewage effluents. Hence, proof of the passage of a *particular* pathogenic microbe through a continuous filter, and through a septic tank and contact beds, may convey to some persons a more definite and tangible illustration of the capability of effluents to retain the potentially dangerous qualities of " untreated " sewage than is apparent from the results of five years' routine work on the biological qualities of sewage effluents.

Moreover, the experiments hereafter to be described throw some light on a point which has received small recognition in the past, namely, the " time relation " between the presence at a given time of a particular microbe in the crude sewage before treatment and the re-appearance of this microbe or of its progeny in the effluent after treatment. This is a matter of considerable interest to the epidemiologist, because " delay " between the casting adrift of a pathogenic microbe from the infected animal host and the re-appearance of the same microbe or of its progeny under conditions potentially provocative of a further spread of disease is a factor which makes for safety. Further, the experiments give some slight indication of the length of time during which pathogenic germs can retain their vitality in a septic tank or in a bacteria bed and pass away with the effluents in a living and virulent condition.

Before dealing with the results of the experiments in detail it is well to bear in mind five considerations, namely :—

(1) That the microbe of experiment was added to the sewage in enormous numbers.

(2) That the results obtained with one kind of micro-organism must not be applied too closely to microbes of separate species.

(3) That there are practical and chemical considerations which merit attention as well as the bacteriological records.

(4) That there is a fundamental distinction between effluents destined to discharge into, on the one hand, drinking and, on the other hand, non-drinking water streams.

(5) That I have isolated occasionally B. pyocyaneus from sewage and from effluents not artificially inoculated with this microbe, so that the micro-organism chosen for experimental purposes is one which is not necessarily always absent from sewage, although its presence therein can only be regarded as exceptional. This fact, however, does not lessen the value of the results if the conditions of experiment be taken into consideration.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

The following is a summary of the contents of this Division of the Report :—

SECTION I.

First B. Pyocyaneus Experiment at Hendon. Continuous filter.

SECTION II.

Second B. Pyocyaneus Experiment at Hendon. Continuous filter.

SECTION III.

First B. Pyocyaneus Experiment at Leeds. Septic tanks and contact beds.

SECTION IV.

Second B. Pyocyaneus Experiment at Leeds. Septic tanks and contact beds.

SECTION V.

General Summary and Conclusions.

SECTION I.

*Description of first B. Pyocyaneus experiment at Hendon. Ducat's filter No. 1.**

1. Fifty oblique agar tubes were, after inoculation with B. pyocyaneus, incubated at 37° C.

2. On the third day (August 7th, 1902) the growth from these tubes was transferred to 300 c.c. of sterile water (B. pyocyaneus emulsion).

3. At 11·10 a.m. on August 7th, 1902, the B. pyocyaneus emulsion was added during a period of three minutes to the sewage as it flowed on to the No. 1 Ducat filter at Hendon.

4. Beginning at 11·20 a.m., cultures were made at intervals of five minutes from the effluent during a period of over five hours.

5. These cultures (1 to 64) were kept under observation in order to ascertain whether or not B. pyocyaneus was present. Generally speaking, the method of culture was as follows :—(a) Primary loop cultures in broth; and (b) Secondary oblique agar cultures. The tubes were incubated at 37° C.

6. The results are shewn in the following table and diagram. It is of interest to note that B. pyocyaneus appeared in the effluent within ten minutes from the start of the experiment, and that virulent B. pyocyaneus was isolated from samples obtained five hours afterwards.

---

* Commenced working August 16th, 1899. Size of filter 15 ft., by 12 ft. or 20 square yards. Depth, 8 ft. 4,000 gallons (200 gallons per square yard) of crude sewage filtered per 24 hours. Size of filtering material (coke) $\frac{1}{2}$ in. to $\frac{3}{4}$ in.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

August 7th, 1902.

11.10 a.m.
11.11 a.m.
11.12 a.m.
11.13 a.m.

During this period of three minutes, the B. pyocyaneus emulsion was added to the sewage flowing on to Ducat filter No. 1.

The following is the result of cultures* subsequently made from the effluent:—

11.20 a.m.	Culture **1**	B. pyocyaneus present	
From 11.20 a.m. until 4.35 p.m. cultures (1 to 64) were made at intervals of five minutes from the effluent.	,, **2**		
	,, **3**		
	,, **4**		
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	,, **8**		
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	,, **10**		
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	,, **22**		
	,, **23**		
	,, **24**		
	,, **25**		
	,, **26**		
	,, **27**		
	,, **28**		
	,, **29**		
	,, **30**		
	,, **31**		
	,, **32**		
	,, **33**		
	,, **34**		
	,, 35	Negative result	As regards the presence of B pyocyaneus.
	,, **36**	*Positive result.*	
	,, 37	Negative result	
	,, **38**	*Positive result*	
	,, **39**		
	,, **40**		
	,, **41**		
	,, 42	Negative result	
	,, **43**	*Positive result*	
	,, 44	Negative result	
	,, **45**	*Positive result*	
	,, **46**		
	,, 47	Negative result	
	,, **48**	*Positive result*	
	,, **49**		
	,, **50**		
	,, **51**		
	,, **52**		
	,, 53	Negative result	
	,, **54**	*Positive result*	
	,, **55**		
	,, **56**		
	,, 57	Negative result	
	,, **58**	*Positive result*	
	,, **59**		
	,, 60	Negative result	
	,, 61		
	,, **62**	*Positive result*	
	,, 63	Negative result	
	,, **†64**	*Positive result*	

---

* The cultures yielding, as regards B. pyocyaneus, a *positive* result are marked in thicker type.

† B. pyocyaneus isolated in pure culture. 1 c.c. and 1/10 c.c. of a broth culture thus obtained were injected subcutaneously into two guinea-pigs (a and b). Both rodents (a and b) died within 24 hours, and in each case B. pyocyaneus was recovered from their heart's blood in pure culture.

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Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

It must not be concluded from this experiment that because B. pyocyaneus when added to the sewage in enormous numbers appeared in the effluent within ten minutes from the commencement of the experiment and continued to escape from the filter for some time afterwards, that a precisely similar result would have been obtained if only a few microbes had been added. Nor must it be inferred that all the bacilli introduced with the onflowing sewage eventually appeared in the effluent. *Still less should it be inferred that the results indicate in any way that the filter was not working satisfactorily from the chemical and practical point of view.* Even from the bacteriological standpoint, this filter, particularly in its earlier days, had yielded remarkably good results. The conclusion to be drawn is rather this:—That a continuous filter, although capable of yielding very good results chemically, and, relatively speaking, good results bacteriologically, cannot be trusted in the case of the discharge of the effluent into a drinking water stream to remove the element of potential danger to health.

It is well worthy of note that particulate matter (in this case the bodies of living bacteria) present in sewage at a given time, although it may pass in part through the filter in a very short space of time, continues to appear in the effluent for some considerable time afterwards. The experiment unfortunately conveys no information as to the time at which the maximum number of B. pyocyaneus were escaping from the filter. It will be noted that cultures 1 to 34 (period of 170 minutes) all yielded B. pyocyaneus (+100%). Cultures 35 to 64 (period of 145 minutes) sometimes yielded B. pyocyaneus and sometimes not (+ 66 %).

That the filter eventually got rid of B. pyocyaneus may be inferred from the earlier control experiments in connection with the second experiment at Hendon (Section II.)

SECTION II

Description of second B. pyocyaneus experiment at Hendon Ducat's filter No. 1.

1. Fifty oblique agar tubes were, after inoculation with B. pyocyaneus, incubated at 37° C.

2. On the third day (Jan. 6th 1903), the growth from these tubes was transferred to 300 c.c. of sterile water (B. pyocyaneus emulsion).

3. At 9.0 a.m. Jan. 6th, 1903, control cultures (1 to 16) were made from the effluent from Ducat's filter No. 1, at intervals of ten minutes until 11.30 a.m.

4. At 11.33 a.m. Jan. 6th, 1903, the B. pyocyaneus emulsion was added during a period of three minutes to the sewage as it flowed on the filter.

5. At 11.33 a.m., and subsequently at intervals of one minute, cultures (17 to 28) were made from the effluent.

6. At 11.47 a.m., and subsequently at intervals of two minutes, cultures (29 to 40) were made from the effluent.

7. At 12.14 p.m., and subsequently at intervals of five minutes, cultures (41 to 52) were made from the effluent.

8. At 1.19 p.m., and subsequently at intervals of ten minutes, cultures (53 to 75) were made from the effluent.

9. At 9 a.m., Jan. 7th, 1903, and subsequently at intervals of one hour cultures (76 to 84) were made from the effluent.

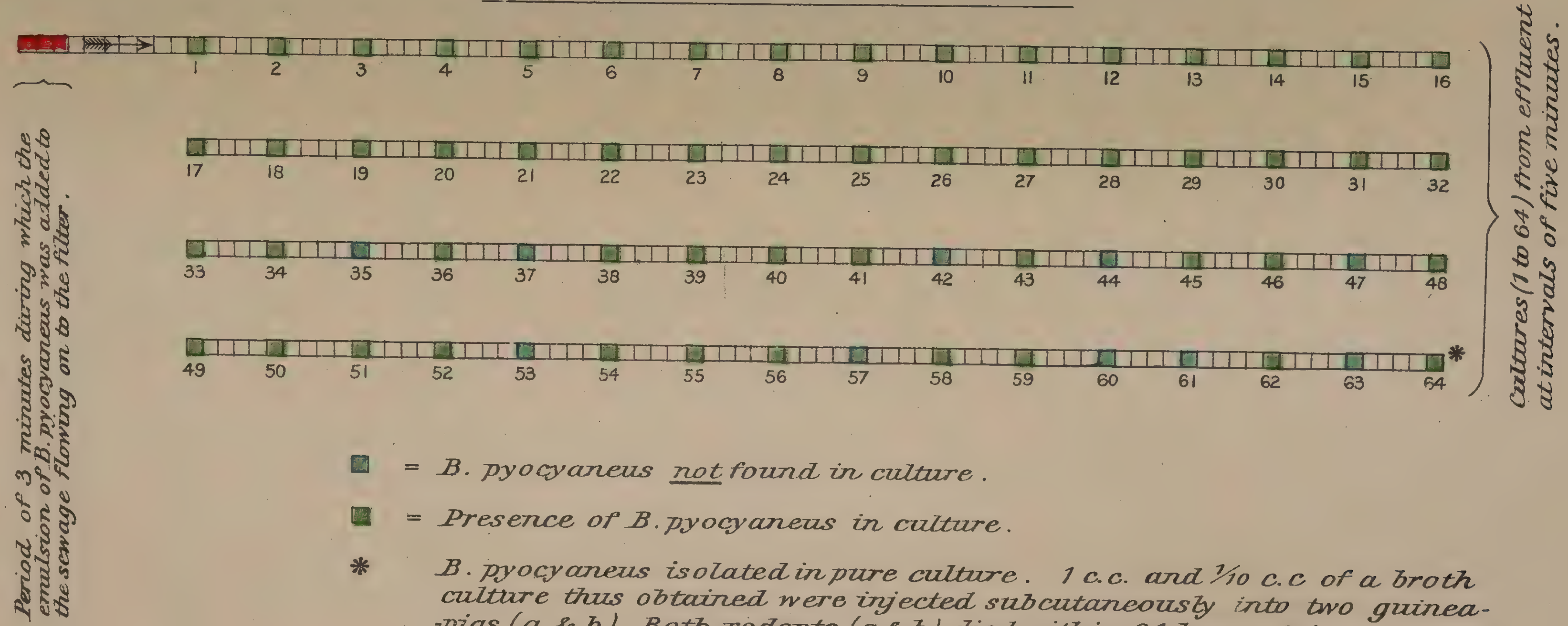
10. Similar cultures (85 to 93) were made on Jan. 8th, 1903.

11. Similar cultures (94 to 102) were made on Jan. 9th, 1903.

12. Similar cultures (103 to 111) were made on Jan. 10th, 1903.

Diagram 1. Illustrating first B. Pyocyaneus experiment at Hendon.

Each square represents one minute.


Period of 3 minutes during which the emulsion of B. pyocyaneus was added to the sewage flowing on to the filter.
1
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64
*
Cultures (1 to 64) from effluent at intervals of five minutes.

🟦 = *B. pyocyaneus* not found in culture.

🟩 = Presence of *B. pyocyaneus* in culture.

* *B. pyocyaneus* isolated in pure culture. 1 c.c. and 1/10 c.c of a broth culture thus obtained were injected subcutaneously into two guinea-pigs (a & b). Both rodents (a & b) died within 24 hours & in each case *B. pyocyaneus* was recovered from the hearts blood in pure culture.

N.B. It will thus be seen that *B. pyocyaneus* appeared in the effluent within ten minutes from the start of the experiment and five hours later was still present in the effluent.

3311.4.03.

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Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

13. Similar cultures (112 to 120) were made on Jan. 12th, 1903.

14. Similar cultures (121 to 129) were made on Jan. 13th, 1903.

15. Similar cultures (130 to 138) were made on Jan. 14th, 1903.

16. Similar cultures (139 to 147) were made on Jan. 15th, 1903.

17. Similar cultures (148 to 156) were made on Jan. 16th, 1903.

18. Similar cultures (157 to 165) were made on Jan. 20th, 1903.

19. Similar cultures (166 to 174) were made on Jan. 22nd, 1903.

20. These cultures (1 to 174) were studied for the presence of B. pyocyaneus. Generally speaking, the method of culture was as follows:—(*a*) Primary loop cultures in broth; (*b*) secondary agar oblique cultures. The tubes were incubated at 37° C.

21. The results are shewn in the following table and diagram. It is of interest to note that B. pyocyaneus appeared in the effluent within eight minutes from the start of the experiment, and was present (at first invariably, later at irregular and increasingly rare intervals) up to the 154th culture (tenth day) in the cultures subsequently made.

January 6th, 1903.

9. 0	a.m.	Culture	1	During this period control cultures were made. The result as regards B. pyocyaneus was negative.
9.10	,,	,,	2	
9.20	,,	,,	3	
9.30	,,	,,	4	
9.40	,,	,,	5	
9.50	,,	,,	6	
10. 0	,,	,,	7	
10.10	,,	,,	8	
10.20	,,	,,	9	
10.30	,,	,,	10	
10.40	,,	,,	11	
10.50	,,	,,	12	
11. 0	,,	,,	13	
11.10	,,	,,	14	
11.20	,,	,,	15	
11.30	,,	,,	16	

January 6th, 1903.

11.33 a.m.	During this period of three minutes the B. pyocyaneus emulsion was added to the sewage flowing on to Ducat filter No. 1.
11.34 ,,	
11.35 ,,	
11.36 ,,	

January 6th, 1903.

During this period cultures were made every minute from the effluent.	11.34	a.m.	Culture	17	Negative results as regards B. pyocyaneus
	11.35	,,	,,	18	
	11.36	,,	,,	19	
	11.37	,,	,,	20	
	11.38	,,	,,	21	
	11.39	,,	,,	22	
	11.40	,,	,,	23	
	11.41	,,	,,	24	
	11.42	,,	,,	***25**	*Positive* results as regards B. pyocyaneus. N.B. It will thus be seen that B. pyocyaneus appeared in the effluent within eight minutes from the start of the experiment. [26, 27, 28 also positive.]
	11.43	,,	,,	**26**	
	11.44	,,	,,	**27**	
	11.45	,,	,,	**28**	

---

* B. pyocyaneus isolated in pure culture. 1c.c. of a broth culture thus obtained was injected subcutaneously into a guinea-pig. A pathogenic effect was produced, but the animal eventually recovered. The cultures yielding, as regards B. pyocyaneus, a *positive* result are marked in thicker type.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

January 6th, 1903.

During this period cultures were made every two minutes from the effluent.

Time		Culture	Result
11.47	a.m.	Culture **29**	All the cultures gave a *positive* result as regards the presence of B. pyocyaneus.
11.49	"	" **30**	
11.51	"	" **31**	
11.53	"	" **32**	
11.55	"	" **33**	
11.57	"	" **34**	
11.59	"	" **35**	
12. 1	p.m.	" **36**	
12. 3	"	" **37**	
12. 5	"	" **38**	
12. 7	"	" **39**	
12. 9	"	" **40**	

January 6th, 1903.

During this period cultures were made every five minutes from the effluent.

Time		Culture	Result
12.14	p.m.	Culture **41**	All the cultures gave a *positive* result as regards the presence of B. pyocyaneus.
12.19	"	" **42**	
12.24	"	" **43**	
12.29	"	" **44**	
12.34	"	" **45**	
12.39	"	" **46**	
12.44	"	" **47**	
12.49	"	" **48**	
12.54	"	" **49**	
12.59	"	" **50**	
1. 4	"	" **51**	
1. 9	"	" **52**	

During this period cultures were made every 10 minutes from the effluent.

Time		Culture	Result
1.19	p.m.	Culture 53	Negative result as regards B. pyocyaneus.
1.29	"	" **54**	*Positive* result as regards B. pyocyaneus.
1.39	"	" **55**	
1.49	"	" **56**	
1.59	"	" **57**	
2. 9	"	" **58**	
2.19	"	" **59**	
2.29	"	" 60	Negative result as regards B. pyocyaneus.
2.39	"	" **61**	*Positive* result as regards B. pyocyaneus.
2.49	"	" **62**	
2.59	"	" **63**	
3. 9	"	" **64**	
3.19	"	" **65**	
3.29	"	" **66**	
3.39	"	" **67**	
3.49	"	" **68**	
3.59	"	" **69**	
4. 9	"	" **70**	
4.19	"	" 71	Negative result as regards B. pyocyaneus.
4.29	"	" 72	
4.39	"	" 73	
4.49	"	" **74**	*Positive* result as regards B. pyocyaneus.
4.59	"	" ***75**	

From 4.59 p.m. January 6th, 1903, to 9 a.m. January 7th, 1903, no cultures were made.

January 7th, 1903.

During this period cultures were made every hour from the effluent.

Time		Culture	Result	
9 a.m.		Culture **76**	*Positive* result	As regards the presence of B. pyocyaneus.
10	"	" 77	Negative result	
11	"	" 78		
12 noon		" 79		
1 p.m.		" 80		
2	"	" **81**	*Positive* result	
3	"	" 82	Negative result	
4	"	" 83		
5	"	" **84**	*Positive* result	

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* B. pyocyaneus isolated in pure culture. 1 c.c. of broth culture injected subcutaneously into a guinea pig. The animal died within 24 hours.

Divison II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

From 5 p.m. January 7th, 1903, to 9 a.m. January 8th, no cultures were made.

January 8th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture 85	Negative result	As regards the presence of B. pyocyaneus.
	10 ,,	,, 86		
	11 ,,	,, 87		
	12 noon	,, 88		
	1 p.m.	,, 89		
	2 ,,	,, **90**	*Positive* result	
	3 ,,	,, 91	Negative result	
	4 ,,	,, 92		
	5 ,,	,, **93**	*Positive* result	

From 5 p.m. January 8th, 1903, to 9 a.m. January 9th, no cultures were made.

January 9th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture **94**	*Positive* result	As regards the presence of B. pyocyaneus.
	10 ,,	,, 95	Negative result	
	11 ,,	,, 96		
	12 noon	,, 97		
	1 p.m.	,, 98		
	2 ,,	,, 99		
	3 ,,	,, 100		
	4 ,,	,, 101		
	5 ,,	,, 102		

From 5 p.m. January 9th, 1903, to 9 a.m. January 10th, no cultures made.

January 10th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture 103	Negative results as regards the presence of B. pyocyaneus.
	10 ,,	,, 104	
	11 ,,	,, 105	
	12 noon	,, 106	
	1 p.m.	,, 107	
	2 ,,	,, 108	
	3 ,,	,, 109	
	4 ,,	,, 110	
	5 ,,	,, 111	

From 5 p.m. January 10th, 1903, to 9 a.m. January 12th no cultures were made.

January 12th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture 112	Negative results as regards the presence of B. pyocyaneus.
	10 ,,	,, 113	
	11 ,,	,, 114	
	12 noon	,, 115	
	1 p.m.	,, 116	
	2 ,,	,, 117	
	3 ,,	,, 118	
	4 ,,	,, 119	
	5 ,,	,, 120	

From 5 p.m. January 12th to 9 a.m. January 13th no cultures were made.

January 13th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture 121	Negative results as regards the presence of B pyocyaneus.
	10 ,,	,, 122	
	11 ,,	,, 123	
	12 noon	,, 124	
	1 p.m.	,, 125	
	2 ,,	,, 126	
	3 ,,	,, 127	
	4 ,,	,, 128	
	5 ,,	,, 129	

From 5 p.m. January 12th to 9 a.m. January 14th no cultures were made.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

January 14th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture 130	Negative result as regards the presence of B. pyocyaneus.
	10 ,,	,, 131	
	11 ,,	,, 132	
	12 noon	,, 133	
	1 p.m.	,, 134	
	2 ,,	,, 135	
	3 ,,	,, 136	
	4 ,,	,, 137	
	5 ,,	,, 138	

From 5 p.m. January 14th to 9 a.m. January 15th, no cultures were made.

January 15th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture **139**	*Positive* result	As regards the presence of B. pyocyaneus.
	10 ,,	,, 140	Negative result	
	11 ,,	,, 141		
	12 noon	,, 142		
	1 p.m.	,, 143		
	2 ,,	,, 144		
	3 ,,	,, 145		
	4 ,,	,, 146		
	5 ,,	,, 147		

From 5 p.m. January 15th, 1903 to 9 a.m. January 16th, no cultures were made.

January 16th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture **148**	*Positive* result	As regards the presence of B. pyocyaneus.
	10 ,,	,, 149	Negative result	
	11 ,,	,, 150		
	12 noon	,, 151		
	1 p.m.	,, 152		
	2 ,,	,, 153		
	3 ,,	,, **154**	*Positive* result	
	4 ,,	,, 155	Negative result	
	5 ,,	,, 156		

From 5 p.m. January 16th, 1903, to 9 a.m. January 20th, no cultures were made.

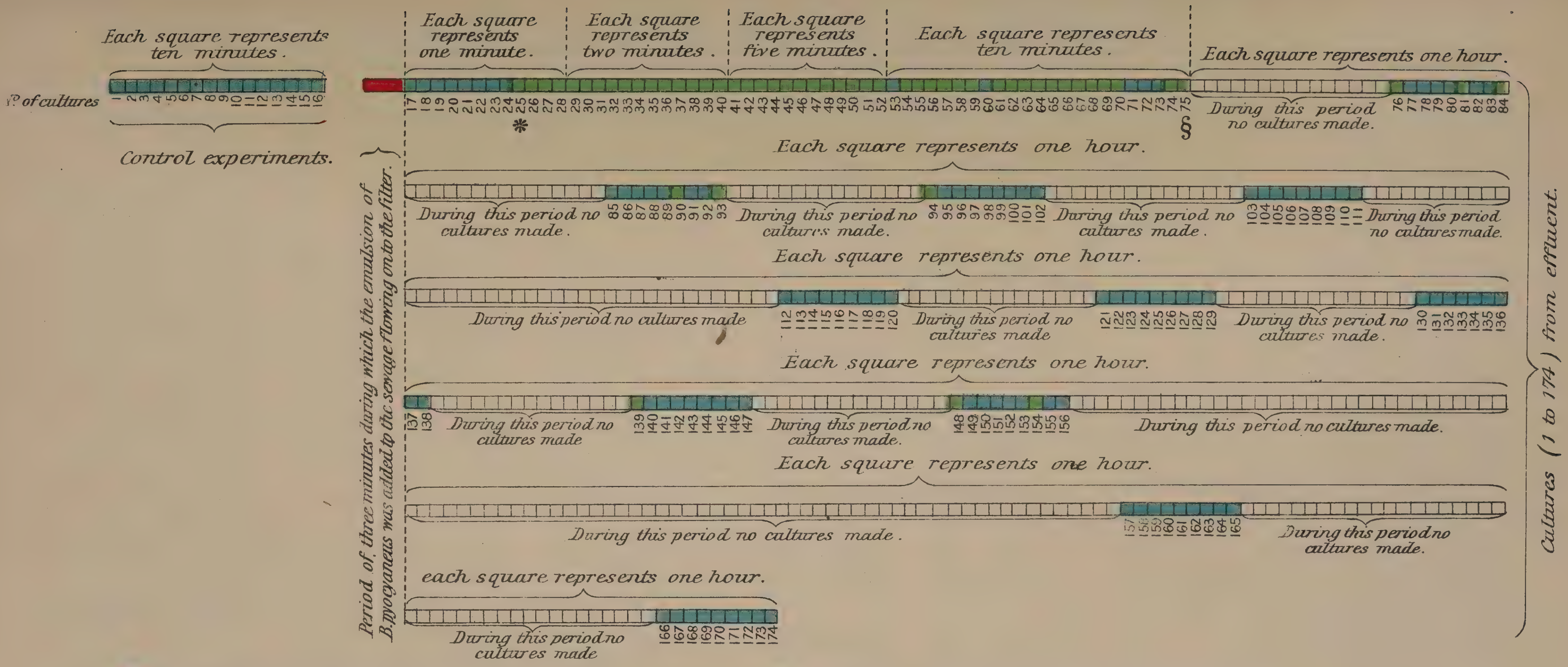
January 20th, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture 157	Negative results as regards the presence of B. pyocyaneus.
	10 ,,	,, 158	
	11 ,,	,, 159	
	12 noon	,, 160	
	1 p.m.	,, 161	
	2 ,,	,, 162	
	3 ,,	,, 163	
	4 ,,	,, 164	
	5 ,,	,, 165	

From 5 p.m. January 20th to 9 a.m. January 22nd, 1903, no cultures were made.

January 22nd, 1903.

During this period cultures were made every hour from the effluent.	9 a.m.	Culture 166	Negative results as regards the presence of B pyocyaneus
	10 ,,	,, 167	
	11 ,,	,, 168	
	12 noon	,, 169	
	1 p.m	,, 170	
	2 ,,	,, 171	
	3 ,,	,, 172	
	4 ,,	,, 173	
	5 ,,	,, 174	



🟦 = Negative result as regards B. pyocyaneus. 🟩 = Positive result as regards B. pyocyaneus.

* = B. pyocyaneus isolated in pure culture. 1 c.c. of a broth culture injected subcutaneously into a guinea-pig produced a pathogenic effect, but the animal eventually recovered.

§ = B. pyocyaneus isolated in pure culture. 1 c.c. of a broth culture injected subcutaneously into a guinea pig. The animal died within 24 hours.

N.B. It will thus be seen that B. pyocyaneus appeared in the effluent within eight minutes from the start of the experiment & in the cultures subsequently made was present (at first invariably, later at irregular & increasingly rare intervals) up to the 154th culture (tenth day).

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It will be noted that all the control cultures (1 to 16) yielded negative results as regards B. pyocyaneus; that B. pyocyaneus appeared in the effluent within eight minutes from the start of the experiment (culture 25); and that in cultures 25 to 52, representing a period of about 87 minutes, B. pyocyaneus was uniformly present (+ 100 %). Cultures 53 to 75, representing a further period of nearly four hours, contained B. pyocyaneus in all but five samples (+ 79 %). Later B. pyocyaneus was only found on rare occasions in the effluent, the last occasion being on the tenth day (154th culture).

Division II.

Passage of B. pyocyaneous through a continuous filter bed and through a sceptic tank and contact beds.

Section III.

*Description of first B. pyocyaneus experiment at Leeds.**

1. One hundred oblique agar tubes were after inoculation with B. pyocyaneus incubated at 37° C.

2. On the third day the growth from these tubes was transferred to 600 c.c. of sterile water (B. pyocyaneus emulsion).

3. At 11.45 a.m. January 21st, 1903, and subsequently, control samples of effluent were collected from the Cameron beds. The times of collection are set forth in the accompanying table.

4. At 9.0 a.m., January 22nd, 1903, and subsequently, control samples were collected from the septic tank liquor at B, *see* Diagram. The times of collection are set forth in the accompanying table.

5. At 12 noon January 22nd, 1903, the emulsion of B. pyocyaneus was added to the sewage as it flowed into the septic tanks at A and A¹ (*see* diagram of installation).

6. The times of collection of subsequent samples of septic tank liquor and effluents from the various beds is stated in the accompanying table.

To avoid any risk of contamination (a) the emulsion was poured on; (b) the samples of septic liquor were taken; and (c) the samples of effluents from the contact beds were collected, by three separate individuals.

7. The samples were collected in sterile bottles and subsequently examined for the presence of B. pyocyaneus: generally by the loop culture in broth method (at 37° C.).

8. The results are shown in the following table and diagram. It is of interest to note that B. pyocyaneus appeared in the septic tank liquor two hours after the start of the experiment, and 24 hours later was still present. Further, that each of the six beds contained B. pyocyaneus in the first emptying subsequent to the passage of this microbe through the septic tank. *i.e.* at the earliest possible opportunity. On the fourth day B. pyocyaneus was still present in the effluents.

9. It may be of interest to include here a brief description of the Cameron installation at Leeds.

Septic Tanks.—There are two tanks each of 20,000 gallons capacity (original capacity) designed to hold 24 hours' flow of sewage. At the time of the experiment, however, they were about half full of sludge. Only one tank was utilised so far as the septic tank experiment was concerned because it was considered that the dilution of 600 c.c. of B. pyocyaneus

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* In connection with the Leeds experiment I desire to acknowledge the efficient help rendered me by Miss Chick.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

emulsion with 20,000 gallons (nominally) of liquid was already enormous (about 1 to 150,800). But as regards the Cameron bed experiment the total bulk of liquid (nominally 40,000 gallons) came into operation since the liquor from the separate tanks unites in a common channel before reaching the alternating gear chamber (*see* diagram of installation).

It is to be noted that, although the septic tanks are constantly filling, they are allowed partially to discharge only once every three hours, each flush filling one bed.

Contact Beds :—There are six beds, worked as follows :—

Filling, about ½ to ¾ hour,
Standing full, about 1 to 1¼ hour,
Emptying, about ½ hour,
Standing empty, about 12 hours,
} Cycle of each of the six beds.

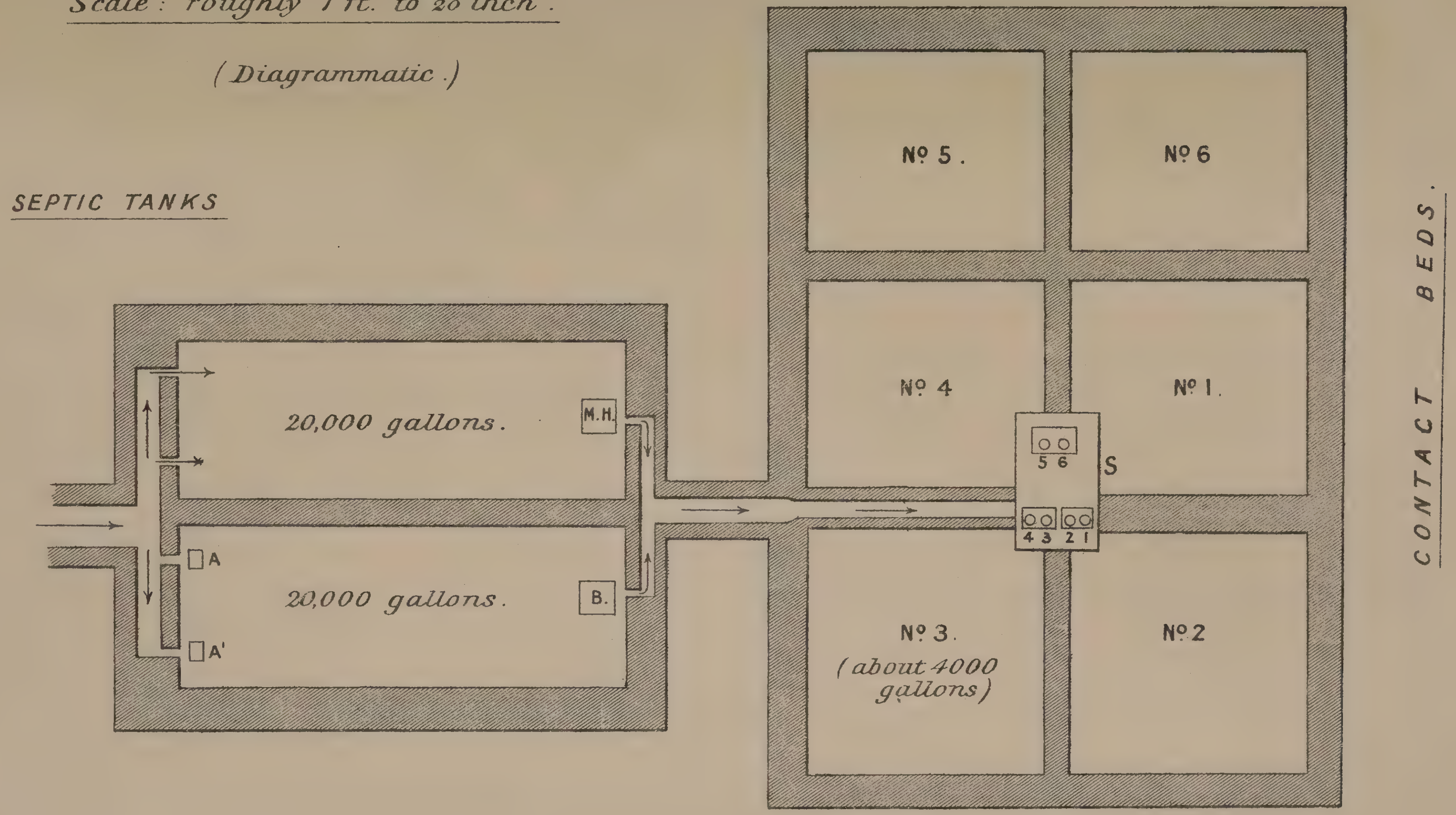
The beds were filled nine to ten times in the 24 hours, each bed in turn resting for 24 hours. In each 24 hours there are five beds working, and nine to ten fillings. Hence each complete cycle takes about 11½ to 14½ hours and each bed is filled almost twice daily. The installation has been at work since September 22nd, 1899.

10. In conclusion I must express my indebtedness to Colonel Harding for his kind permission to carry out the experiments at Leeds. I am also greatly indebted to Mr. W. H. Harrison for placing every possible facility in my way, and for his active co-operation and willing help in conducting the experiments.

Septic Tank followed by Contact Beds (one contact)

Scale: roughly 1 ft. to $\frac{1}{20}$ inch.

(Diagrammatic.)



Emulsion of B. pyocyaneus added at A & A'

Samples of Septic Tank effluent taken at B.

Samples of effluents from Filter Beds taken in the Alternating Gear Chamber S, *at* 1, 2, 3, 4, 5 & 6.

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Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds

FIRST EXPERIMENT AT LEEDS.

Hour.	Day.	CLOSED SEPTIC TANK LIQUOR.			CAMERON BED EFFLUENTS.			
		No. of Culture.	Remarks as regards Collection of Samples.	Results as regards presence of B. pyocyaneus in septic tank liquor.	No. of Culture.	No. of Bed.	Remarks as regards Collection of Samples.	Results as regards presence of B. pyocyaneus in the effluent.
11.45 a.m.	Jan. 21				1	III.		Negative.
12.15 p.m.								
12.45 ,,								
1.15 ,,								
1.45 ,,								
2.15 ,,					2	IV.		Bottle broken.
2.45 ,,								
3.15 ,,								
3.45 ,,								
4.15 ,,								
4.45 ,,					3	V.		Negative.
5.15 ,,								
5.45 ,,								
6.15 ,,								
6.45 ,,								
7.15 ,,					4	VI.		,,
7.45 ,,								
8.15 ,,								
8.45 ,,								
9.15 ,,								
9.45 ,,								
10.15 ,,					5	I.		,,
10.45 ,,								
11.15 ,,							Sample collected at pipe distributing into effluent chamber.	
11.45 ,,								
12.15 a.m.	Jan. 22							
12.45 ,,								
1.15 ,,					6	III.		,,
1.45 ,,								
2.15 ,,								
2.45 ,,								
3.15 ,,								
3.45 ,,								
4.15 ,,					7	IV.		,,
4.45 ,,								
5.15 ,,								
5.45 ,,			All the samples were collected at manhole in closed septic tank.					
6.15 ,,								
6.45 ,,					8	V.		,,
7.15 ,,								
7.45 ,,								
8.15 ,,								
8.45 ,,								
9.15 ,,		1		Negative	9	VI.		,,
9.45 ,,		2		,,				
10.15 ,,		3		,,				
10.45 ,,		4		,,				
11.15 ,,		5	*B. pyocyaneus added to sewage flowing into septic tank. At 12 noon.*	,,	10	I.	*B. pyocyaneus added to sewage flowing into septic tank. At 12 noon.*	,,
11.45 ,,		6		,,				
12.15 p.m.	1st day	7		,,				
12.45 ,,		8		,,				
1.15 ,,		9		,,				
1.45 ,,		10		,,	11	II.		,,
2.15 ,,		**11**		*Positive*				
2.45 ,,		**12**		,,				
3.15 ,,		**13**		,,			½ run off...	
3.45 ,,		**14**	Samples 1, 5, 6, 10, 11, 12, 16, 17, 18, 19, 21, 22, 25, 26, 28, 29, 30, 31, 32, 33, 35, 37, 38 were collected while tank was emptying.	,,				
4.15 ,,		**15**		,,	12	IV.		,,
4.45 ,,		**16**		,,				
5.15 ,,		**17**		,,				
5.45 ,,		**18**		,,				
6.15 ,,		**19**		,,				
6.45 ,,		**20**		,,	**13**	V.	5 minutes from start ...	*Positive.*
7.15 ,,		**21**		,,	**14**		½ run off	,,
7.45 ,,		**22**		,,	**15**		15 minutes after finish	,,
8.15 ,,		**23**		,,				
8.45 ,,		**24**		,,				
9.15 ,,		**25**		,,	16	VI.	5 minutes from start ...	Negative,
9.45 ,,					**17**		½ run off	*Positive.*
10.15 ,,		**26**	Samples 2, 3, 4, 7, 8, 9, 13, 14, 15, 20, 23, 24, 27, 34, 36, 39, 40 were collected while tank was filling.	,,				
10.45 ,,					**18**		15 minutes after finish	,,
11.15 ,,		**27**		,,	**19**	I.	5 minutes from start ...	,,
11.45 ,,					**20**		½ run off	,,
12.15 a.m.	Jan. 23	**28**		,,	**21**		15 minutes after finish	,,
12.45 ,,								
1.15 ,,		**29**		,,				
1.45 ,,					**22**	II.	5 minutes from start ...	,,
2.15 ,,		**30**		,,	**23**		½ run off	,,
2.45 ,,					**24**		15 minutes after finish	,,
3.15 ,,		**31**		,,				
3.45 ,,					**25**	IV.	5 minutes from start ...	,,
4.15 ,,		**32**		,,	**26**		½ run off	,,
4.45 ,,					27		15 minutes after finish	Negative.
5.15 ,,		**33**		,,				
5.45 ,,								
6.15 ,,		**34**		,,	28	V.	5 minutes from start ...	Bottle broken
6.45 ,,					29		½ run off	Negative.
7.15 ,,		**35**		,,	**30**		15 minutes after finish	*Positive.*
7.45 ,,								

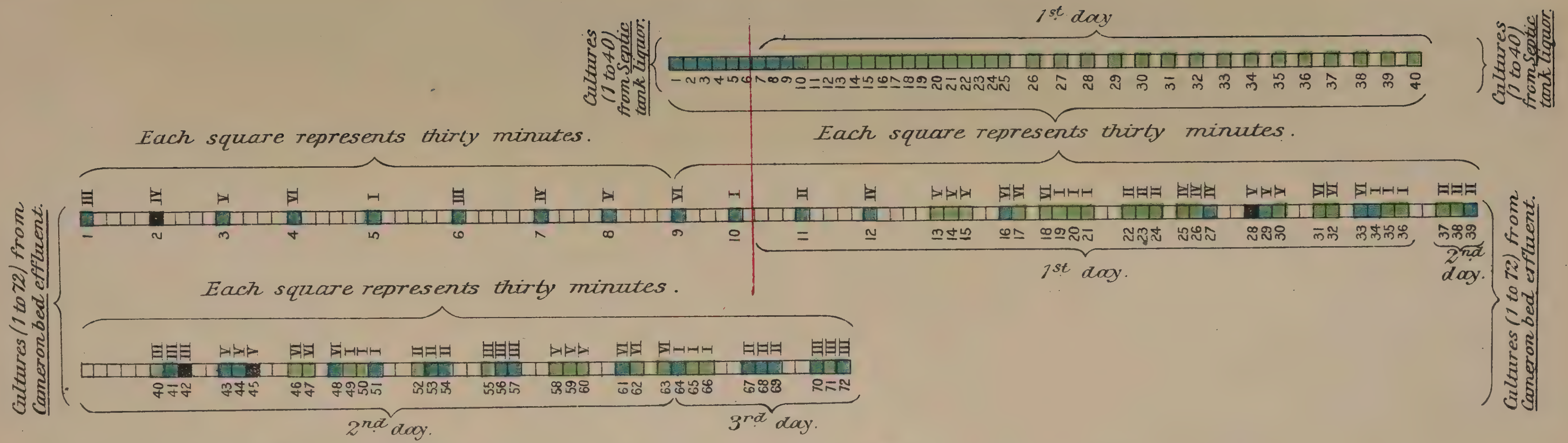
N.B.—The cultures yielding, as regards B. pyocyaneus, a *positive* result are marked in thicker type.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

FIRST EXPERIMENT AT LEEDS.—(*cont.*)

Hour.	Day.	Closed Septic Tank Liquor. No. of Culture.	Closed Septic Tank Liquor. Remarks as regards Collection of Samples.	Closed Septic Tank Liquor. Results as regards presence of B. pyocyaneus in septic tank liquor.	Cameron Bed Effluents. No. of Culture.	Cameron Bed Effluents. No. of Bed.	Cameron Bed Effluents. Remarks as regards Collection of Samples.	Cameron Bed Effluents. Results as regards presence of B. pyocyaneus in the effluent.
8.15 a.m.	1st day (Jan.23)	**36**		*Positive*				
8.45 ,,					**31**	VI.	5 minutes from start ...	*Positive.*
9.15 ,,		**37**		,,	**32**		½ run off	,,
9.45 ,,								
10.15 ,,		**38**		,,	33		15 minutes after finish	Negative.
10.45 ,,					34	I.	5 minutes from start ...	,,
11.15 ,,		**39**		,,	**35**		½ run off	*Positive.*
11.45 ,,					**36**		15 minutes after finish	,,
12 15 p.m.	2nd day	**40**		,,				
12.45 ,,			During this period no samples of septic tank liquor were collected.	During this period no samples of septic tank liquor were collected.				
1.15 ,,					**37**	II.	5 minutes from start ...	,,
1.45 ,,					**38**		½ run off	,,
2.15 ,,					39	II.	15 minutes after finish	Negative
2.45 ,,								
3.15 ,,								
3.45 ,,								
4.15 ,,								
4.45 ,,								
5.15 ,,					**40**	III.	5 minutes from start ...	*Positive.*
5.45 ,,					41		½ run off	Negative.
6.15 ,,					42		15 minutes after finish	Bottle broken.
6.45 ,,								
7.15 ,,								
7.45 ,,					43	V.	5 minutes from start ...	Negative.
8.15 ,,					44		½ run off	,,
8.45 ,,					45		15 minutes after finish	Bottle broken.
9.15 ,,								
9.45 ,,								
10.15 ,,					**46**	VI.	5 minutes from start ...	*Positive.*
10.45 ,,					**47**		½ run off	,,
11.15 ,,								
11.45 ,,					48		15 minutes after finish	Negative.
12.15 a.m.	(Jan.24)				**49**	I.	5 minutes from start ...	*Positive*
12.45 ,,					**50**		½ run off	,,
1.15 ,,					51		15 minutes after finish	Negative.
1.45 ,,								
2.15 ,,								
2.45 ,,					**52**	II.	5 minutes from start ...	*Positive.*
3.15 ,,					53		½ run off	Negative.
3.45 ,,					54		15 minutes after finish	,,
4.15 ,,								
4.45 ,,								
5.15 ,,					**55**	III.	5 minutes from start ...	*Positive.*
5.45 ,,					56		½ run off	Negative.
6.15 ,,					57		15 minutes after finish	,,
6.45 ,,								
7.15 ,,								
7.45 ,,					**58**	V.	5 minutes from start ...	*Positive.*
8.15 ,,					**59**		½ run off	,,
8.45 ,,					**60**		15 minutes after finish	,,
9.15 ,,								
9.45 ,,								
10.15 ,,					61	VI.	5 minutes from start ...	Negative.
10.45 ,,					**62**		½ run off	*Positive.*
11.15 ,,								
11.45 ,,					**63**		15 minutes after finish	,,
12.15 p.m.	3rd day				64	I.	5 minutes from start ...	Negative.
12.45 ,,					**65**		½ run off	*Positive.*
1.15 ,,					**66**		15 minutes after finish	,,
1.45 ,,								
2.15 ,,								
2.45 ,,					67	II.	5 minutes from start ...	Negative.
3.15 ,,					68		½ run off	,,
3.45 ,,					69		15 minutes after finish	,,
4.15 ,,								
4.45 ,,								
5.15 ,,					70	III.	5 minutes from start ...	,,
5.45 ,,					**71**		½ run off	*Positive.*
6.15 ,,					72		15 minutes after finish	Negative.



🟦 = *B. pyocyaneus not found in the cultures.* (■ = *sample bottle broken.*)

🟩 = „ „ *present in the cultures.*

The vertical red line indicates the time at which the B. pyocyaneus emulsion was added to the sewage flowing into the septic tank.

The Roman numerals refer to the different beds.

N.B. *It will thus be seen that B. pyocyaneus appeared in the septic tank liquor two hours after the commencement of the experiment and 24 hours later was still present. Further that the effluents from each of the six beds contained B. pyocyaneus in the first emptying subsequent to the passage of this microbe through the septic tank & into the beds, i.e. at the earliest possible opportunity. On the third day B. pyocyaneus was still present in the effluents.*

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Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

It will be noted that the control experiments (cultures 1 to 6 septic tank liquor; cultures 1 to 10 contact bed effluents) contained no B. pyocyaneus. Two hours after the commencement of the experiment B. pyocyaneus was present (culture 11) in the septic tank liquor, and 24 hours later (culture 40) was still present. Indeed, all the cultures between No. 11 and No. 40 contained B. pyocyaneus (+ 100 %). As regards the contact beds B. pyocyaneus appeared in the effluents at the earliest possible opportunity, *i.e.*, in the first emptying, subsequent to the passage of this microbe through the septic tank and into the beds. On the third day B. pyocyaneus was still present in the effluents. But that B. pyocyaneus eventually disappeared from the septic tank and beds is apparent from the control experiments in connection with the second Leeds experiment (Section IV.).

The experiment shows the danger of accepting statements which seek to prove that the effluents respectively from septic tanks or from contact beds preceded by septic tank treatment are necessarily non-pathogenic. It also shows that there may be a wide difference between the theoretical rate of flow through a septic tank and the actual rate of flow.

SECTION IV.

Description of second B. Pyocyaneus Experiment at Leeds, February 18th to February 28th, 1903.

1. This second experiment was carried out in exactly the same manner, except that the number of samples taken and examined was considerably greater than in the previous experiment.

2. Samples of the septic tank liquor were taken half-hourly from 9 a.m. February 19th until 9 a.m. February 21st. A few samples were also taken on February 27th.

3. Samples of the effluent from the Cameron beds were taken frequently (three at each emptying) from 9.45 a.m. February 18th until 5.35 p.m. February 21st, and at less frequent intervals until February 28th.

4. The emulsion (600 c.c.) of B. pyocyaneus was added to the sewage entering the septic tank at 12 noon February 19th.

5. The result of this experiment was substantially the same as that of the previous one. The B. pyocyaneus was detected in the septic tank effluent 2½ hours after the emulsion containing that microbe had been added to the sewage entering the tank, and in the filter bed effluent 4½ hours afterwards. This occurred in the effluent leaving Bed I., which was the first bed to empty after B. pyocyaneus had been detected in the septic tank liquor.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

SECOND EXPERIMENT AT LEEDS.

Hour.	Day.	Closed Septic Tank Liquor.			Cameron Bed Effluents.			
		No. of Culture.	Remarks as regards Collection of Samples.	Results as regards presence of B. pyocyaneus in septic tank liquor.	No. of Culture.	No. of Bed.	Remarks as regards Collection of Samples.	Results as regards presence of B. pyocyaneus in the effluent.
9.30 a.m.	Feb. 18				1	V.	5 minutes from start ...	Negative.
10. 0 ,,					2	,,	½ run off	,,
10.30 ,,					3	,,	15 minutes after finish...	,,
11. 0 ,,								
12. 0 noon					4	V.	5 minutes from start ...	,,
12.30 p.m.					5	,,	½ run off	,,
1. 0 ,,								
1.30 ,,					6	;,	15 minutes after finish...	,,
2. 0 ,,					7	I.	5 minutes from start ...	,,
2.30 ,,					8	,,	½ run off	,,
3. 0 ,,					9	,,	15 minutes after finish...	,,
3.30 ,,								
4. 0 ,,								
4.30 ,,					10	II.	5 minutes from start ...	,,
5. 0 ,,					11	,,	½ run off	,,
5.30 ,,					12	,,	15 minutes after finish...	,,
6. 0 ,,								
6.30 ,,								
7. 0 ,,								
7.30 ,,					13	III.	5 minutes from start ...	,,
8. 0 ,,					14	,,	½ run off	,,
8.30 ,,					15	,,	15 minutes after finish...	,,
9. 0 ,,								
9 30 ,,								
10. 0 ,,								
10.30 ,,					16	IV.	5 minutes from start ...	,,
11. 0 ,,					17	,,	½ run off	,,
11.30 ,,					18	,,	15 minutes after finish...	,,
12. 0 mid.	Feb. 19							
12 30 a.m.			All samples were collected at the manhole in closed septic tank.					
1. 0 ,,								
1.30 ,,					19	VI.	5 minutes from start ...	,,
2. 0 ,,					20	,,	½ run off	,,
2.30 ,,					21	,,	15 minutes after finish...	,,
3. 0 ,,					22	I.	5 minutes from start ...	,,
3.30 ,,					23	,,	½ run off	,,
4. 0 ,,					24	,,	15 minutes after finish...	,,
4.30 ,,								
5. 0 ,,								
5.30 ,,								
6. 0 ,,					25	II.	5 minutes from start ...	,,
6.30 ,,					26	,,	½ run off	,,
7. 0 ,,					27	,,	15 minutes after finish...	,,
7.30 ,,								
8. 0 ,,								
8.30 ,,								
9. 0 ,,		1		Negative.	28	III.	5 minutes from start ...	,,
9.30 ,,		2		,,	29	,,	½ run off	,,
10. 0 ,,		3		,,	30	,,	15 minutes after finish...	,,
10.30 ,,		4		,,				
11. 0 ,,		5		,,				
11.30 ,,		6		,,	31	IV.	5 minutes from start ...	,,
12. 0 noon	1st day	7	*B. pyocyaneus added to sewage flowing into septic tank. At 12 noon.*	,,	32	,,	½ run off	,,
12.30 p.m.		8		,,	33	,,	15 minutes after finish...	,,
1. 0 ,,		9		,,				
1.30 ,,		10		,,				
2. 0 ,,		11		,,	34	V.	5 minutes from start ...	,,
2.30 ,,		**12**	Samples 2, 3, 4, 7, 8, 9, 12, 13, 14, 17, 18, 19, 22, 23, 24, 28, 29, 32, 33, 34, 38, 39, 40, 48, 49, 50, 55, were collected while tank was emptying.	*Positive.*	35	,,	½ run off	,,
3. 0 ,,		**13**		,,	36	,,	15 minutes after finish...	Bottle broken.
3.30 ,,		**14**		,,				
4. 0 ,,		**15**		,,	**37**	I.	5 minutes from start ...	*Positive.*
4.30 ,,		**16**		,,	**38**	,,	½ run off	,,
5. 0 ,,		**17**		,,	**39**	,,	15 minutes after finish...	,,
5.30 ,,		**18**		,,				
6. 0 ,,		**19**		,,				
6.30 ,,		**20**		,,				
7. 0 ,,		**21**		,,	**40**	II.	5 minutes from start ...	,,
7.30 ,,		**22**		,,	**41**	,,	½ run off	,,
8. 0 ,,		**23**		,,	**42**	,,	15 minutes after finish...	,,
8.30 ,,		**24**		,,				
9. 0 ,,		**25**		,,				
9.30 ,,		**26**		,,				
10. 0 ,,		27		Negative.	**43**	III.	5 minutes from start ...	,,
10.30 ,,		**28**		*Positive.*	**44**	,,	½ run off	,,
11. 0 ,,		**29**	Samples 1, 5, 6, 10, 11, 15, 16, 17, 20, 21, 25, 26, 27, 30, 31, 35, 36, 37, 41, 42, 43, 45, 46, 47, 51, 52, 53, 54, were collected while tank was filling.	,,	**45**	,,	15 minutes after finish...	,,
11.30 ,,		**30**		,,				
12. 0 mid.	Feb. 20	**31**		,,				
12.30 a.m.		**32**		,,	**46**	IV.	5 minutes from start ...	,,
1. 0 ,,		**33**		,,	**47**	,,	½ run off	,,
1.30 ,,		**34**		,,	**48**	,,	15 minutes after finish...	,,
2· 0 ,,		**35**		,,				
2.30 ,,		**36**		,,				
3. 0 ,,		**37**		,,				
3.30 ,,		**38**		,,	**49**	V.	5 minutes rom start ...	,,
4. 0 ,,		**39**		,,	**50**	,,	½ run off	,,
4.30 ,,		**40**		,,	**51**	,,	15 minutes after finish...	,,
5. 0 ,,		**41**		,,				
5.30 ,,		**42**		,,	**52**	I.	5 minutes from start ...	
6. 0 ,,		**43**		,,	**53**	,,	½ run off	,,

N.B.—The cultures yielding, as regards B. pyocyaneus, a *positive* result are marked in thicker type.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

SECOND EXPERIMENT AT LEEDS—(*cont.*)

Hour.	Day.	Closed Septic Tank Liquor.			Cameron Bed Effluents.			
		No. of Sample.	Remarks as regards Collection of Samples.	Results as regards presence of B. pyocyaneus in septic tank liquor.	No. of Sample.	No. of Bed.	Remarks as regards Collection of Samples.	Results as regards presence of B. pyocyaneus in the effluent.
6.30 a.m.	Feb. 20	44		*Positive*	54	I.	15 minutes after finish...	*Positive*
7. 0 "		45		"				
7.30 "		46		"				
8. 0 "		47		"	55	II.	5 minutes from start ...	"
8.30 "		48		"	56	"	½ run off	"
9. 0 "		49		"	57	"	15 minutes after finish...	"
9.30 "		50		"				
10. 0 "		51		"				
10.30 "		52		"				
11. 0 "		53		"	58	III.	5 minutes from start ...	"
11.30 "		54		"	59	"	½ run off	"
12. 0 noon	2nd day	55		"	60	"	15 minutes after finish...	"
12.30 p.m.		56	Samples 56, 60, 61, 62, 65, 66, 67, 68, 71, 72, 73, 76, 77, 78, 82, 83, 84, 87, 88, 89, 92, 93, 94, 97 were collected while tank was emptying.	"				
1. 0 "		57		"				
1.30 "		58		"				
2. 0 "		59		"	61	IV.	5 minutes after start ...	"
2.30 "		60		"	62	"	½ run off	"
3. 0 "		61		"	63	"	15 minutes after finish ...	"
3.30 "		62		"				
4. 0 "		63		"				
4.30 "		64		"	64	V.	5 minutes after start ...	"
5. 0 "		65	Samples 57, 58, 59, 63, 64, 69, 70, 74, 75, 79, 80, 81, 85, 86, 90, 91 were collected while tank was filling.	"	65	"	½ run off	"
5.30 "		66		"	66	"	15 minutes after finish ...	"
6. 0 "		67		"				
6.30 "		68		Bottle broken				
7. 0 "		69		" "				
7.30 "		70		*Positive*	67	VI.	5 minutes after start ...	Bottle broken
8. 0 "		71		"	68	"	½ run off	*Positive*
8.30 "		72		"				
9. 0 "		73		Bottle broken	69	"	15 minutes after finish ...	"
9.30 "		74		*Positive*				
10. 0 "		75		"	70	II.	5 minutes after start ...	"
10.30 "		76		"	71	"	½ run off	"
11. 0 "		77		"	72	"	15 minutes after finish ...	"
11.30 "		78		"				
12. 0 mid.	Feb. 21	79		"				
12.30 a.m.		80		"				
1. 0 "		81		"	73	III.	5 minutes after start ...	"
1.30 "		82		"	74	"	½ run off	"
2. 0 "		83		"	75	"	15 minutes after finish ...	"
2.30 "		84		"				
3. 0 "		85		"				
3.30 "		86		Bottle broken	76	IV.	5 minutes after start ...	"
4. 0 "		87		*Positive*	77	"	½ run off	"
4.30 "		88		"	78	"	15 minutes after finish ...	"
5. 0 "		89		"				
5.30 "		90		"				
6. 0 "		91		"	79	V.	5 minutes after start ...	"
6.30 "		92		Bottle broken	80	"	½ run off	"
7. 0 "		93		*Positive*	81	"	15 minutes after finish ...	Negative
7.30 "		94		"				
8. 0 "		95		"				
8.30 "		96		"				
9. 0 "		97		"	82	VI.	5 minutes after start ...	"
9.30 "					83	"	½ run off	"
10. 0 "								
10.30 "					84	"	15 minutes after finish ...	"
11. 0 "					85	I.	5 minutes after start ...	*Positive*
11.30 "					86	"	½ run off	Negative
12. 0 noon	3rd day				87	"	15 minutes after finish ...	"
12.30 p.m.								
1. 0 "								
1.30 "								
2. 0 "								
2.30 "					88	III.	5 minutes after start ...	*Positive*
3. 0 "					89	"	½ run off	"
3.30 "					90	"	15 minutes after finish ...	Negative
4. 0 "								
4.30 "								
5. 0 "					91	IV.	5 minutes after start ...	*Positive*
5.30 "					92	"	½ run off	"
6. 0 "					93	"	15 minutes after finish ...	"

During the period (Feb. 21st to 27th) no samples of septic tank liquor or of Cameron Bed Effluents were collected.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

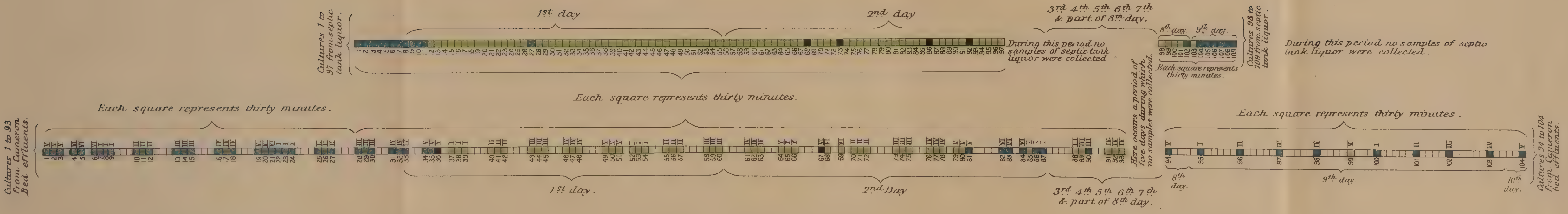
SECOND EXPERIMENT AT LEEDS.—(*cont.*)

Hour.	Day.	CLOSED SEPTIC TANK LIQUOR.			CAMERON BED EFFLUENT.			
		No. of Sample.	Remarks as regards Collection of Samples.	Results as regards presence of B. pyocyaneus in septic tank liquor.	No. of Sample.	No. of Bed.	Remarks as regards Collection of Samples.	Results as regards presence of B. pyocyaneus in the effluent.
10. 0 a.m.	Feb. 27	**98**	Samples 99, 100, 101, 104, 105, 106, were collected while tank was emptying.	*Positive.*				
10.30 ,,	8th day	**99**		,,	94	V.	½ run off	Negative.
11. 0 ,,		**100**		,,				
11.30 ,,		**101**		,,				
12. 0 noon	9th day	102		Negative.				
12·30 p.m.		**103**		*Positive.*				
1. 0 ,,		104		Negative.	95	I.	,, ...	,,
1.30 ,,		105		,,				
2. 0 ,,		106	Samples 98, 102, 103, 107, 108, 109, were collected while tank was filling.	,,				
2.30 ,,		107		Not positive.				
3. 0 ,,		108		,,				
3.30 ,,		109		,,	96	II.	,, ...	,,
4. 0 ,,			During this period no samples of septic tank liquor were collected.	During this period, no samples of septic tank liquor were collected.				
4.30 ,,								
5. 0 ,,								
5.30 ,,								
6. 0 ,,								
6.30 ,,								
7. 0 ,,					97	III.	,, ...	,,
7.30 ,,								
8. 0 ,,								
8.30 ,,								
9. 0 ,,								
9.30 ,,								
10. 0 ,,					98	IV.	,, ...	,,
10.30 ,,								
11. 0 ,,								
11.30 ,,								
12. 0 mid.	Feb. 28							
12.30 a.m.					**99**	V.	,, ...	*Positive.*
1. 0 ,,								
1.30 ,,								
2. 0 ,,								
2.30 ,,					100	I.	,, ...	Negative.
3. 0 ,,								
3.30 ,,								
4. 0 ,,								
4.30 ,,								
5. 0 ,,								
5.30 ,,					101	II.	,, ...	,,
6. 0 ,,								
6.30 ,,								
7. 0 ,,								
7.30 ,,								
8. 0 ,,					102	III.	,, ...	,,
8.30 ,,								
9. 0 ,,								
9.30 ,,								
10. 0 ,,								
10.30 ,,								
11. 0 ,,					103	IV.	,, ...	,,
11.30 ,,								
12. 0 noon	10th day							
12.30 p.m.								
1. 0 ,,								
1.30 ,,					104	V.	,, ...	,,
2. 0 ,,								
2.30 ,,								
3. 0 ,,								
3.30 ,,								

It will be noted that none of the control experiments (cultures 1 to 7 septic tank liquor; cultures 1 to 31 contact bed effluents) contained B. pyocyaneus, so that it may be inferred that since the first experiment (carried out about one month previously) the septic tank and contact beds had practically got rid of this microbe. B. pyocyaneus appeared in the septic tank liquor 2½ hours after the beginning of the experiment (culture 12) and all the cultures (with one exception), made subsequently at half-hourly intervals during a period of nearly two days, gave a positive result (cultures 13 to 97). On the eighth day after the commencement of the experiment B. pyocyaneus was still present in some of the cultures.

As regards the contact bed effluents B. pyocyaneus appeared in the first emptying of the beds subsequent to the passage of this microbe through the septic tank and into the beds, *i.e.* at the earliest possible opportunity. About 90 per cent. of the cultures (37 to 93) collected during a period of 54 hours from the effluents from the six contact beds contained B. pyocyaneus. On the eighth, ninth and tenth days further cultures (94 to 104) were made, but in only one case (culture 99; ninth day) was a positive result obtained.

Diagram 5 illustrating second B. pyocyaneus experiment at Leeds.



▪ = B. pyocyaneus not found in the cultures. (■ = Sample bottle broken.)

▫ = „ „ present in the cultures.

The vertical red line indicates the time at which the B. pyocyaneus emulsion was added to the Sewage flowing into the septic tank.

The Roman numerals refer to the different beds.

It will be seen that B. pyocyaneus appeared in the septic tank liquor 2½ hours after the beginning of the experiment, and 41 hours afterwards was still present; and further, that the effluents from each of the six beds contained B. pyocyaneus in the first emptying subsequent to the passage of the microbe through the septic tank, i. e. at the earliest possible opportunity. On the 9th day B. pyocyaneus was still present in the septic tank liquor and was present also in a contact bed effluent.

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SECTION V.

General Summary and Conclusions.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

In summary of the foregoing it is important to note—

(*a*) That in the case of the continuous bed (Sections I. and II., Experiments 1 and 2) B. pyocyaneus appeared in the effluents within *less than ten minutes* from the start of the experiment, and was present (at first invariably, later at irregular and increasingly rare intervals) for some considerable time afterwards in the cultures subsequently made (at least 5 hours, Experiment 1; ten days Experiment 2). But that the filter eventually rid itself, practically speaking, of B. pyocyaneus is also evident from the control experiments (Experiment 2) and is also indicated by the negative results obtained with the later cultures in the same experiment (Experiment 2).

(*b*) That in the case of the septic tank and contact bed (Sections III. and IV., Experiments 1 and 2) B. pyocyaneus appeared in the septic tank liquor *within 2½ hours* from the start of the experiment, and in the contact bed effluents at the earliest possible time, *i.e.*, the first emptying of the bed after the passage of B. pyocyaneus through the septic tank and into the beds. In Experiment 1, B. pyocyaneus was still present in the septic tank liquor 24 hours from the start of the experiments and in the contact bed effluent up to the third day. In Experiment 2, which was carried over a longer period, B. pyocyaneus was isolated from the septic tank liquor and from a contact bed effluent on the ninth day. Nevertheless, as in the case of the continuous bed, B. pyocyaneus did not seem capable of existing in the septic tank or contact beds for an unlimited length of time (control experiments of Experiment 2 and also the negative results in the later cultures made in connection with Experiment 2).

Three points remain to be dealt with :—

I. The rapidity with which a proportion of the added B. pyocyaneus microbes appeared in the continuous bed effluent (within ten minutes), the septic tank liquor (within three hours), and the contact bed effluents (the first emptying). Assuming that in connection with the continuous bed and the septic tank and contact bed systems of sewage "treatment," there are processes at work which gradually make for the destruction of pathogenic germs, it is difficult to believe that these processes could, in a short space of time, exercise any very material influence on the vitality or biological attributes of microbes of any kind. In brief, the experiments seem to indicate that a proportion of the total number of microbes contained in each unit of sewage may escape prolonged exposure to the influences above referred to, and these bacteria can hardly be expected to undergo any marked modification in their biological characters during their brief sojourn in the beds or in the septic tank.

II. The comparatively long time during which B. pyocyaneus remained alive in the continuous filter, septic tank, and contact beds, seems to indicate that prolonged "treatment" would not suffice necessarily for the certain destruction of pathogenic bacteria. Nevertheless, we have no means of knowing the proportion of B. pyocyaneus which may have perished during the course of each experiment.

III. The *ultimate* disappearance* of B. pyocyaneus, notwithstanding the fact of its being present at first in enormous numbers from

---

* How far this disappearance was a purely mechanical one it is impossible to say; nor can it be said what was the relation between the total number of B. pyocyaneus that escaped in the effluents and the total number originally added to the sewage. If B. pyocyaneus multiplied at all in the continuous filter, septic tank, and contact beds, the rate of multiplication must have been slow as compared with the continuous destruction or "washing out" of the bacilli in question.

Division II.

Passage of B. pyocyaneus through a continuous filter bed and through a septic tank and contact beds.

the continuous filter, septic tank, and contact beds, is of interest. It would seem to indicate that such pathogenic germs as may be judged to be adventitious (so far as the process of purification is concerned) gradually disappear from septic tank and bacteria beds. In any case, there was no indication, indeed the reverse, of sustained multiplication of B. pyocyaneus in the continuous filter, septic tank, and contact beds.

Broadly speaking, the results tend to confirm my previous statements and inferences.

They indicate the inadvisability of relying on septic tanks, contact beds, and continuous filters to remove altogether the element of potential danger to health associated with the discharge of effluents from these processes of sewage treatment into *drinking water* streams.

This statement in no way implies that *these processes of sewage treatment are not capable of yielding satisfactory effluents from the chemical and practical point of view and in relation to non-drinking water streams.*

DIVISION III.

The Bacteriological Examination of Samples of Unpolluted Sea Water.

SUMMARY OF CONTENTS.

I.—Description of the Samples of Sea Water, page 99.

II.—Methods of Examination, page 101.

III.—Results, page 101.

IV.—General Conclusions, page 101.

  (*a*) General Observations, page 101.

  (*b*) The Question of Standards, page 102.

    (1.) *From the Numerical Point of View*, page 103.

    (2.) *In relation to Biological Characters*, page 104.

    (3.) *Tests to be employed for differential purposes*, page 106.

    (4.) *Summary*, page 106.

V.—Summarised Conclusions, page 109.

[Map of the West Coast of Scotland, illustrating the sites of collection of the various samples of sea water.

Diagrams 1 and 2 showing the vitality of B. coli respectively in *unpolluted* sea water and in tap water.]

Division III.

Bacteriological Examination of Unpolluted Sea Water.

The Bacteriological Examination of Samples of Unpolluted Sea-water.

In view of a number of conflicting statements as to the distribution of B. coli in nature, it seemed desirable to ascertain in connection with the shell-fish inquiry to what extent microbes of excremental origin are present in large volumes of non-polluted sea-water. With this object a special investigation was carried out with the following results :—

Dr. Gordon, at the end of July 1903, visited the West Coast of Scotland, and personally collected and transmitted to me numerous samples of unpolluted sea-water. In work of this kind much care and judgment are required, not alone in the choice of localities, but in the manner of collecting samples. That this portion of the investigation was carried out by my colleague is sufficient warrant that it was well done.

I am also much indebted to Miss Power for assisting me in the examination of the samples.

The following is Dr. Gordon's description of the samples of sea-water, and it is accompanied by his map illustrating approximately the sites of collection.

I.—DETAILS OF SAMPLES OF SEA-WATER.

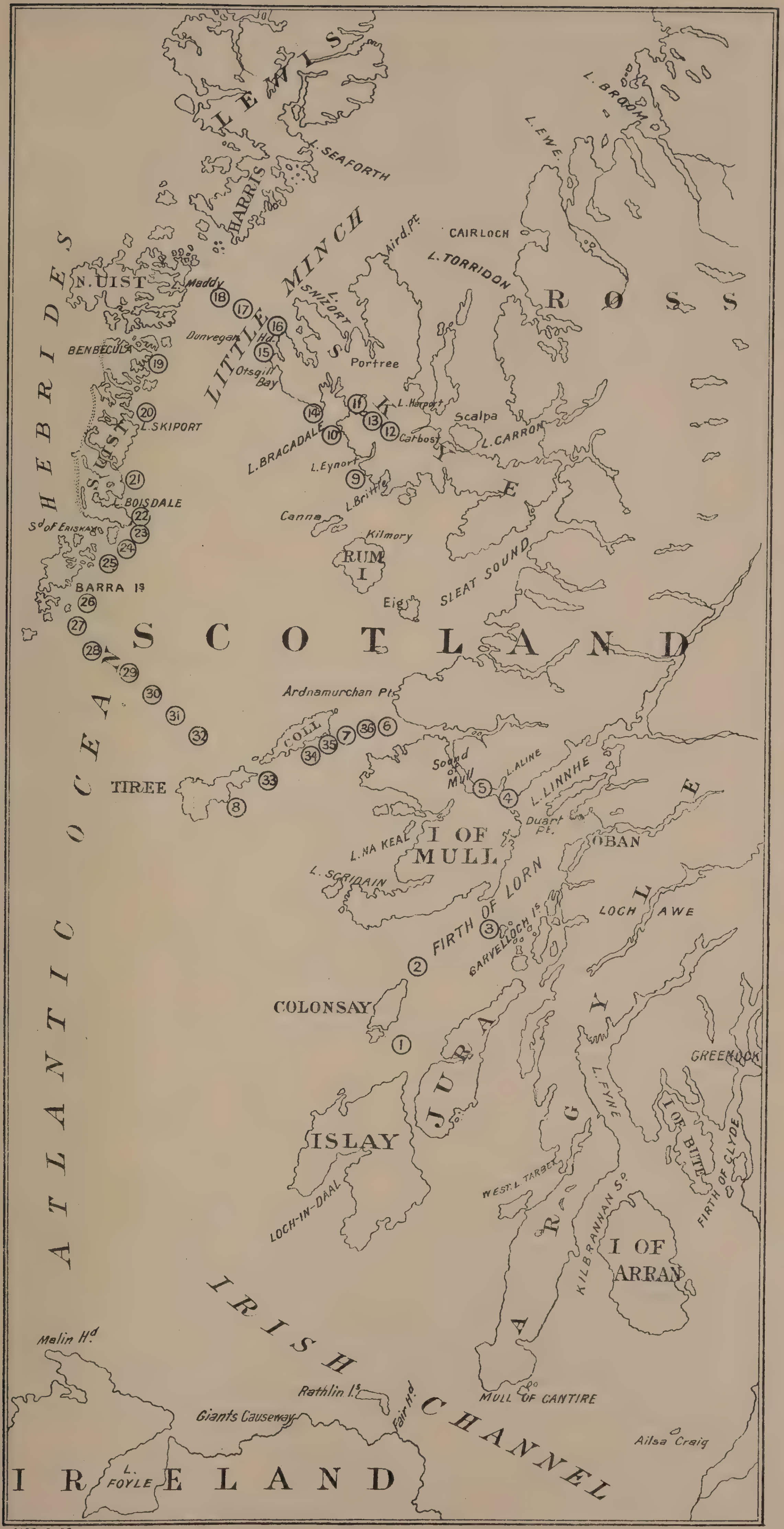
COLLECTED OFF THE WEST COAST OF SCOTLAND, JULY 28TH–AUGUST 1ST 1903.

Date and Number of Sample.	Particulars.
July 28th 1903	
1	Half-way across the channel between the Islands of Islay, Jura and Colonsay.
2	Between Colonsay and the islands in the Firth of Lorn called "Garvelloch" Islands, or "Isles of the Sea."
3	About 300 yards from the shore of the Garvelloch Islands.
4	In the Sound of Mull, off Duart Point.
5	Sound of Mull, off Ardtornish Castle, and entrance to Loch Aline.
6	Between Ardnamurchan Point and Mull.
7	Between Ardnamurchan Point and the Island of Coll. Diving birds are fairly numerous. The surface of the sea quite smooth.
8	Off the Island of Tiree.
July 29th 1903	
9	Off the Coast of Skye, between Lochs Brittle and Eynort.
10	Off Skye. Between Lochs Eynort and Bracadale.
11	Inside Loch Bracadale (Skye). Many jelly fish.
12	*Sample taken from the shore about ¼ mile above distillery at Carbost, Skye. Cottage gardens within 50 yards and cottages within about 100 yards. [The only sample taken from shore.]*
13	Sample taken (after scalding out sampling vessel) in Loch Harport, Skye, about a mile from Carbost.
14	Sample taken just outside Loch Bracadale, Skye, about ½ mile outside th rocks known as McLeod's Maidens.
15	Off Otsgill Bay, Skye.

DETAILS OF SAMPLES OF PURE SEA-WATER—*continued.*

COLLECTED OFF THE WEST COAST OF SCOTLAND, JULY 28TH–AUGUST 1ST 1903—*continued.*

Date and Number of Sample.	Particulars.
July 29th 1903.	
16	Off Dunvegan Head, Skye.
17	Little Minch Channel. Between Dunvegan, Skye, and Loch Maddy, Hebrides. [*This sample was broken in transit.*]
18	Another sample of the same.
July 30th 1903.	
19	Between Scotvin and Carnan, off the Island of Benbecula, Hebrides.
20	Off the Mouth of Loch Skiport, in the Island of South Uist, Hebrides.
21	Between Loch Skiport and Loch Boisdale in the same island.
22	About ½ mile out in Loch Boisdale, *i.e.*, about ½ mile from some houses on the shore.
23	Opposite the Sound of Eriskay.
24	Opposite the middle of the Island of Eriskay.
25	Opposite the Sound of Barra.
26	Opposite the Islands of Barra.
July 31st 1903.	
27	The Atlantic, between Barra and Coll.
28	Ditto
29	Ditto.
30	Ditto.
31	Ditto.
32	Ditto. Nearing junction of Islands of Coll and Tiree.
33	Between Islands of Coll and Tiree.
34	Between Coll and Mull.
35	Another sample, same channel.
36	Another sample of same, between Ardnamurchan Point and Mull.



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Scale, 20 Miles to One Inch.

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Division III.

Bacteriological Examination of Unpolluted Sea Water.

II.—METHODS OF EXAMINATION.

B. coli test.

100 c.c., 10 c.c., and 1 c.c. of the water were in each instance used for cultural purposes.

Dr. MacConkey's bile salt, glucose, peptone medium was employed as a preliminary test. As pointed out in my Report to the Commission on Bacteriological Methods, this test in its positive aspect may not always be trustworthy as regards proof of the presence of B. coli, but when this test yields *negative* results the absence of B. coli and of glucose-fermenting coli-like microbes may be accepted *without reserve.* For the 100 c.c. and 10 c.c. cultures the medium was prepared of double strength and sterilised in flasks and large test tubes containing 100 c.c. and 10 c.c. respectively.

B. enteritidis sporogenes test.

10 c.c. and 1 c.c. cultures were in each instance made in sterile milk, previously rendered slightly alkaline to avoid curdling of the milk on the addition of the sea-water.

III.—RESULTS.

The following is a summary of the results* :—

B. coli test, including all glucose fermenting coli-like microbes.	34 out of 35 samples (practically 97%) yielded an absolutely negative result, even when using for cultural purposes 100 c.c. of water. 1 out of the 35 samples (about 3%) gave a positive result with 10 c.c.,† but not with 1 c.c. This sample (No. 12), it was subsequently ascertained from Dr. Gordon's notes, was the only sample collected from the shore, and the only instance in which the local conditions were of an unfavourable kind. These facts were not, owing to Dr. Gordon's absence, elicited until *after* the examination had been completed. This single exception to the otherwise totally negative results must therefore be regarded rather as proving than as disproving the practical utility of bacteriological tests in this connection.
B. enteritidis sporogenes test.	None of the samples yielded a positive result even when using for cultural purposes 10 c.c. of water.

IV.—GENERAL CONCLUSIONS.

(a) General Observations.

Excluding No. 12, none of the samples of sea-water contained B. coli or spores of B. enteritidis sporogenes, even when using for cultural purposes as much as 100 c.c. and 10 c.c. respectively of the samples. These facts speak for themselves. It is obvious therefore that these microbes may be entirely absent from a large volume of sea-water collected at the surface in situations altogether remote from objectionable pollution. It follows therefore that

---

* Sample 17 is excluded from consideration, the bottle having been broken in transit.

† The biological characters of the B. coli isolated from both the 100 c.c. and 10 c.c. cultures of this sample were as follows :—Gas in gelatine "shake" cultures ; indol in broth cultures ; acid and clot in litmus milk culture : namely, positive results in each case.

Division III.

Bacteriological Examination of Unpolluted Sea Water.

B. coli. and B. enteritidis sporogenes form no necessary part of the bacterial flora of sea water, though these micro-organisms are present in excremental matters in overwhelming abundance. In view of the range of difference in this sense between sewage and sea-water—100,000 B. coli per c.c. in sewage, and no coli-like microbes of any sort in 100 c.c. of unpolluted sea-water—there is opportunity afforded to the bacteriologist for exercising his test without drifting on to the Scylla of impractibility, or the Charybdis of over-estimation of *potential* danger to health.

From Dr. Gordon's notes and map, it would appear that many of the samples were collected at no extreme distance from the land,* and that bird† and fish life was sometimes abundant in the locality whence the sample was derived.

It is indisputable that the presence of birds and fish and also of drainage from manured land, may, as regards water samples, affect bacteriological results. But, practically speaking, this consideration does no more than suggest the prudence of not pushing an extremely delicate test *too far*, and of not laying undue significance on the *mere presence* of B. coli.

However this may be, the comparative proximity of land, although sparsely populated, and the presence of birds and fish did not, in the instances now in question and *in the absence of sewage pollution*, appreciably lead to the bacterial contamination of the sea-water. This, of course, accords with experience of fresh water. Here, too, the presence of birds, fish and land drains has to be considered. But, practically and generally speaking, B. coli is not found in pure water, and on the contrary is found in abundance in water known to be objectionably polluted. A serious objection, *if it were tenable*, to the B. coli test would be that B. coli fortuitously introduced into a pure water multiplies therein to a noteworthy and progressive extent. But although bacteriologists are prepared to admit the possible multiplication in water of B. coli under peculiarly favourable circumstances, the results of research all point to the somewhat rapid loss of vitality of B. coli in *pure* water under laboratory conditions of experiment. The accompanying diagrams speak for themselves. They show that B. coli added to sea-water and tap-water in large amount was no longer capable of demonstration in 1 c.c. of the sample, after a maximum of nine days and a minimum of three days. A negative result with 1 c.c. does not mean necessarily the absolute death of B. coli, but it certainly indicates the relative disappearance of this microbe from the sample. The persistence of B. coli in polluted water and in mud is a separate question.

This report, primarily intended to be a simple exposition of facts, involves issues of considerable practical importance. It is, therefore, impossible to avoid touching on matters which are of necessity controversial.

(b) *The Question of Standards.*

At the present time the attempt to lay down *absolute* standards is not justifiable, as the following considerations serve to show. Even tentative standards for working purposes are possibly open to criticism.

It seems too little understood that it is only of quite recent years that any attempt has been made to estimate accurately both the number and the biological characters of B. coli in waters of diverse sort, in soils, in sewage, in sewage effluents, and in fæces. Time must be given to collect, digest and compare the array of facts already ascertained, in order to arrive at valid inferences. Time also must elapse while such provisional interpretations of our facts as appear now justifiable are still further experimentally tested.

Further, an assumption that B. coli is directly injurious seems unwise if not unwarrantable in the present state of knowledge. The only safe view is

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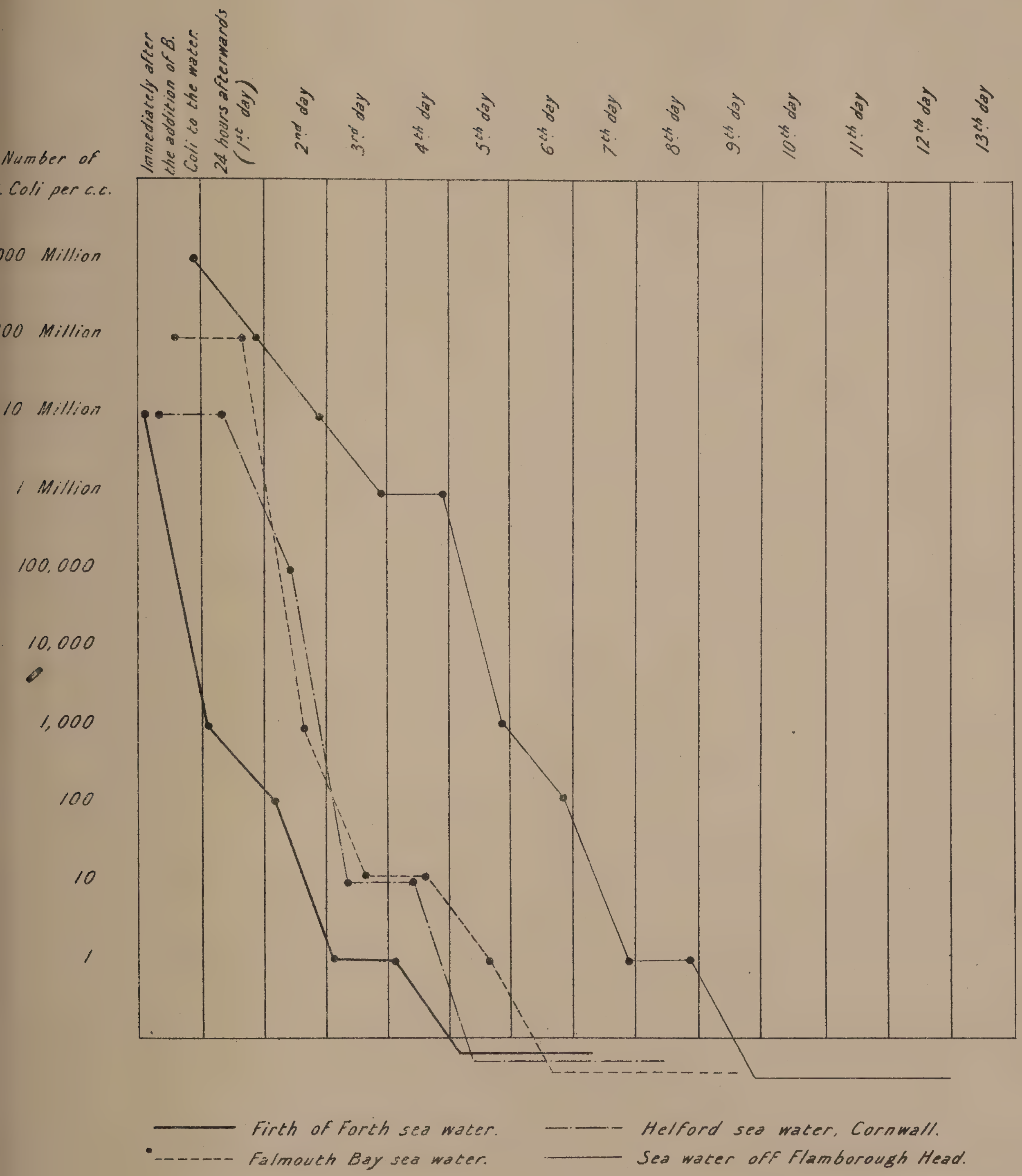
* All the samples were collected within sight of land.

† It is always possible to have our clothes soiled by the dejecta of a passing bird. Yet we use umbrellas for rain and not for self-protection in this other sense. Bacteriology is not exempt from apparent anomalies, but those who have had experience in these matters regard them as relatively unimportant. Few tests are absolute, yet many of them are, relatively speaking, very valuable. The B. coli test is one of such. It is enough if by its use the percentage error arising from conclusions based on mere topographical conjecture is lessened. No fair-minded critic will attempt to deny the relative merits of the test.

Diagram 1 shewing the Vitality of B. Coli in Sea Water.

The water, not previously sterilised and contained in a glass stoppered bottle, was inoculated with an emulsion made from a fresh agar culture of typical B. Coli. After vigorous shaking cultures were made and on each successive day further cultures were made. The bottle was kept in the incubator at 20°C.



N. B. A negative result with 1 c.c. does not indicate necessarily the absolute death of B. Coli, but it certainly indicates its relative disappearance from the sample.

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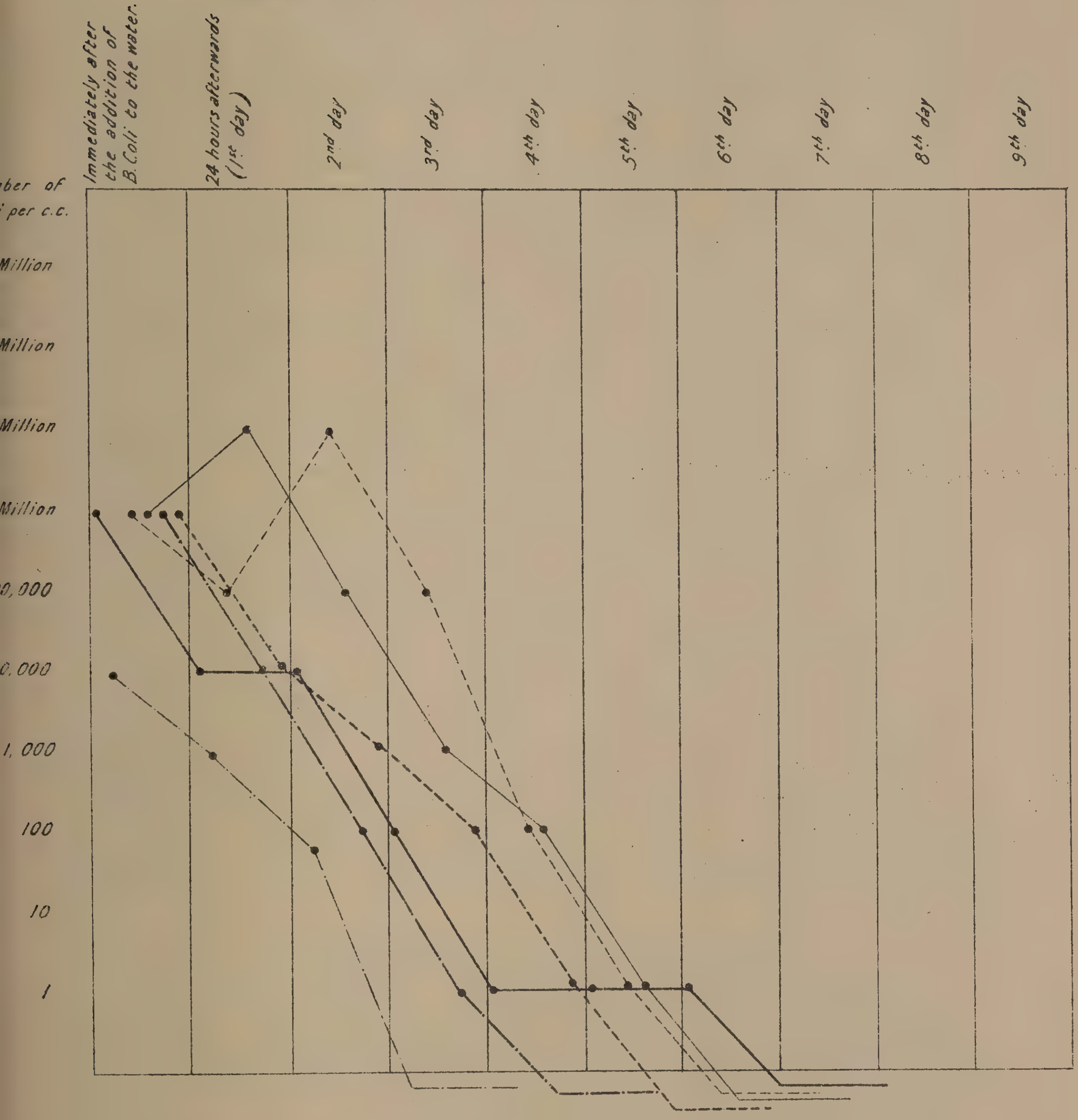
Diagram 2 shewing the Vitality of B. Coli in Tap Water.

Six separate Experiments.

The water, not previously sterilised and contained in a glass stoppered bottle, was inoculated with an emulsion made from a fresh agar culture of typical B. Coli. After vigorous shaking cultures were made, and on each successive day further cultures were made. The bottle was kept in the incubator at 20° C.



N. B. A negative result with 1 c.c. does not indicate necessarily the absolute death of B. Coli, but it certainly indicates its relative disappearance from the sample.

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that the B. coli test is an *indirect* index of potential danger to health. In this latter sense absolute standards are to be deprecated. In the absence of more perfect knowledge, it may be convenient and permissible to measure the degree of danger to health by the numerical abundance of an intestinal microbe (B. coli), apt to be associated on occasion, although in quite unknown proportion, with bacteria of definitely pathogenic sort. Nevertheless, it is perfectly well known, or ought to be understood, that neither the epidemiologist nor the chemist, nor even the bacteriologist, can place a "*disease value*" on any given pollution. Instances are not wanting when gross pollution of water of sudden or even continued sort has not been associated with grave consequences. On the other hand, examples of wide-spread epidemics traced to pollution of water supply of seemingly trivial sort again and again attract the serious attention of epidemiologists. Those having most reason to speak authoritatively on these matters admit the paucity of our knowledge of water-borne epidemics and the existence of controlling factors in relation to the spread of disease by water concerning which our knowledge is practically *nil.*

Nevertheless, it is not to be contended that the division of waters into classes may not be attended with practical advantages. It may even prove useful for practical purposes to draw a definite line and to object to all waters giving results above, and to pass all waters giving results below, this arbitrary standard. But we must be prepared to admit that such a standard, wherever the line be drawn, is no more than an index; based, it is true, on actual figures of the degree of pollution, and hence broadly of the extent of *potential* danger to health, but that it has not a constant or definite "disease value." Further, it ought to be understood that, wherever possible, multiple analyses should be made, and the results interpreted by aid of local conditions.

In a recent report to the Local Government Board, now in the press, I have adopted, as regards B. coli, what would seem to be the only safe method. In this report there are given in parallel columns; (1), waters arranged according to what may be termed a decimal mode of bacterial classification, with accompanying remarks of tentative sort; and (2), all the best known tests for B. coli, with the percentage number of coli of human fæcal origin, which give a positive result with each of these tests.

In the first class of waters are placed all those containing no coli-like microbes in 100 c.c.

In the second class, are waters giving a positive result with 100 c.c., but a negative result with 10 c.c.

In the third class, are waters giving a positive result with 10 c.c., but a negative result with 1 c.c.

In the fourth class, are waters giving a positive result with 1 c.c., but a negative result with 0·1 c.c., and so on.

Now it is obvious that in this connexion the subject must be approached from the point of view both of (1) number and (2) character of coli-like microbes.

(1). *Standards from the Numerical Point of View.*

As regards this question, in connection with my Chichester Well Water Reports of 1900–1 and 1901–2, I took upon myself the responsibility of not laying too much stress on the presence of B. coli in 100 c.c. if it were absent from 10 c.c. of the water samples; of regarding with suspicion a water containing B. coli in 10 c.c. but not in 1 c.c.; and of objecting to a water containing B. coli in 1 c.c., even if this microbe were absent from 0·1 c.c. This is, whether for sea-water or fresh-water, as far as I care to go at present, and means that, in practice I would *cæteris paribus* object to a water of the fourth class, regard with suspicion a water of the third class, consider a water of the second class not wholly satisfactory, and *upon the basis of results* unconditionally pass a water of the first class.

Of course, it is evident that waters, between the second and third and between the third and fourth classes, may be arranged in subclasses according to whether they yield positive results with 100, 90, 80, 70, 60, 50, 40, 30, or 20 c.c., or 10, 9, 8, 7, 6, 5, 4, 3, or 2 c.c., and so forth. But whether our knowledge is sufficiently advanced to make this desirable is another matter.

It will be noted that the line is absolute* so far as the fourth class is concerned; tentative as regards the third class; and problematical in respect of class two.

In reference to objection to absolute standards I may point out that Dr. Stafford, in his cross-examination of witnesses before the Commission, has again and again emphasized the point that even as regards large communities all sewages are not to be thought of as alike in morbific value. For example, the sewage of Dublin has a higher potential enteric morbific value than the sewage of London. This is in virtue of the fact that enteric fever in Dublin has been endemic in serious degree for many years. Yet the B. coli test would fail absolutely to detect this difference.

Again, a B. coli pollution of, say, one B. coli per 10 c.c. of water would be on one footing if the contamination were known to be extremely *recent* in character although sparse in amount, and on a different, although indeterminate, footing if the pollution originally gross in amount were so altered by "delay" and unfavourable physical conditions as to yield on bacteriological examination a parallel result.

To take concrete examples:—A mere trickle of *fresh* sewage into an oyster pit would suggest grave danger. Gross pollution of an estuary by discharge of sewage at a point far distant from oyster layings is also objectionable, but not in quite the same sense.

Further, a B. coli pollution of, say, 1 per c.c. due to the dejecta of an enteric fever patient would be of the gravest significance, but if such a B. coli pollution were known to be derived from a non-specific source, it would be, relatively speaking, unobjectionable.

These are arguments not against the employment of the B. coli test, but against the too hasty creation and administrative application of absolute standards irrespective of local topographical data.

Nevertheless, I see no reason why waters should not *a priori* be absolutely condemned; viewed with some suspicion; regarded as still showing appreciable although slight evidence of pollution probably of intestinal origin; and considered "safe" according to whether they fall under respectively the fourth, third, second, and first class; *subject always, however, in the matter of final conclusions to the carrying out of multiple analyses and the interpretation of the results in the light of a knowledge of the local conditions.*

It might, and indeed would, occasionally happen in actual practice that a knowledge of the local circumstances would lead either the epidemiologist or the topographist to consider the danger in some cases greater, in others less, than appeared from the actual bacteriological results. Powers of topographical observation are denied to none, and medical bacteriologists must necessarily possess as well some knowledge of epidemiology. Bacteriologists in this category are the first to admit that they would wish to see their results interpreted in the light of local conditions.

(2). *Standards in Relation to Biological Characters.*

Passing next to the difficult question of identity of species, it may be said at the outset that it is as regards the finer issues of the B. coli test that doubts and controversy arise. Bacteriologists ever pressing forward to the unattainable goal of absolute knowledge are apt to leave in their wake a track of nebulous hypothesis which to the uninstructed observer may suggest superficial, not as ought to be the case, merely incomplete knowledge.

It cannot be denied that non-liquefying coli-like microbes which ferment glucose, lactose, and cane sugar; which reduce neutral red and also nitrate broth; which form indol; which produce in milk acid and clot, are hardly ever found in pure water, whereas they are present in enormous number in human fæces, in sewage, in sewage effluents, and in sewage-polluted water. Even in this crude and limited sense the *present* practical utility of bacterial testing is abundantly proved.

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* That is, absolute on the basis of results; not absolute necessarily in the presence of a knowledge of the local conditions of a sort likely to modify inferences founded merely on bacteriological facts

It is when the attempt is made to probe the matter further, and to seek to differentiate between the coli of the higher as compared with coli of the lower animals, the coli of the diseased as contrasted with coli of the healthy intestine, the coli of *recent* in contra-distinction to the coli of remote intestinal origin, that the problem becomes as difficult as it is attractive.

In the report to the Local Government Board already referred to, an analysis is given of the biological characters of 101 B. coli isolated from the normal stools of healthy persons. The percentage of these fæcal B. coli responding to each of the numerous tests considered characteristic of B. coli is given, but it is not stated in the report exactly where the line should be drawn in rejecting coli-like microbes which fail as regards one or more of these tests. Nor can it be said with certainty which tests should be employed, and how many of them. It would be extremely easy, in theory, to insist on the employment of a large number of tests, and to affirm that a given microbe must yield positive results with them all for it to be considered fæcal in origin. As regards the former it is always difficult, in routine work almost impossible, and in some cases perhaps, unnecessary, greatly to multiply tests for proof of identity.

In respect of the latter point there are many objections. For example there is the vexed problem of "loss of attribute," concerning which present knowledge is very meagre. Further, it is beyond controversy that sewage and sewage effluents and waters and soils known to be objectionally polluted may swarm with coli-like microbes, many of which may fail in one or more respects to meet the somewhat arbitrary requirements for proof of identity with classical B. coli. The picking out of coli-like colonies for study in pure culture is after all even to the expert a *speculative venture.* Who can say of two seemingly typical B. coli colonies in gelatine plate cultures that one and not the other, or that both or that neither, will produce indol, or ferment lactose, or "change" neutral red. Yet these aberrations occur in everyday practice. We may indeed multiply our subcultures; but this involves much extra labour and may mean curtailing work in other and more important directions. Nor are we prepared to say that the coli-like microbes which respond feebly or not at all to one or even more of our positive tests for B. coli have not a real if subordinate meaning in relation to objectionable pollution.

For these and other reasons, it has been and is contended that the nearest approach to the truth is reached by pitting number against characters and *vice versa.** That is, the greater the number of coli-like microbes in a material the less should *complete* fulfilment of all the positive attributes of B. coli be insisted on in the case of those colonies picked out as a speculation for study in pure culture. Conversely, the more closely the coli-like microbes respond to the various tests the greater the justification for stringent standards as regards numerical abundance. Of course, it is impossible to suggest any formula to link together "number" and "characters." It cannot for example be said that because a coli-like microbe fails as regards indol formation, or clotting of milk, or "changing" neutral red, or fermentation of lactose that the numerical results must be divided by X figure.

The important point is to aim at obtaining always a negative as well as a positive result as regards *number* of coli-like microbes; to isolate and to study in *pure* culture one or more strains of coli-like microbes from the last

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* For example, a water containing in 1 c.c. a microbe indistinguishable from the typical B. coli of the human intestine would be objected to. Another water containing in $\frac{1}{100}$ c.c. coli-like microbes which on subculture were not in all respects quite typical of B. coli, might, I think, also be objected to on the grounds of their great numerical abundance and on the not unlikely assumption that the completely typical races of B. coli were likewise present, although probably in smaller proportion. Coli-like microbes of any sort ought perhaps to be viewed with some degree of suspicion *per se;* in most instances they are a useful index as well of the possible or probable presence of completely typical B. coli in a sample. The incontestable fact in connection with the present investigation is that no coli-like microbes of any sort were present in 100 c.c. in each instance of a considerable number of samples of unpolluted sea water.

(highest) dilution* yielding microbes of this kind; to employ as many tests as is reasonably practicable, and to place on record in detail all the facts elicited. A full and detailed statement of facts may remain of value long after the inferences founded on these facts have been forgotten.

(3). *Tests to be employed in differentiating coli-like microbes.*

This must needs vary in different cases, and it is not necessary in every instance to employ all the tests here set forth. Yet it is always important to give in detail exactly what tests have been applied, so that the value of the results may be appraised accordingly. The most useful tests are, I consider, the following†:—Gas formation in ordinary gelatine "shake" cultures; indol in broth cultures; acid and clot in litmus milk cultures; greenish-yellow fluorescence in neutral-red broth cultures; gas and acid in lactose-peptone cultures; gas, acid and clot in peptone-lactose milk cultures; gas and acid in glucose-peptone cultures; reduction of nitrate to nitrite in nitrate broth cultures; strong acid in Proskauer and Capaldi's medium No. 1; no definite production of acid in Proskauer and Capaldi's medium No. II.; presence of motility; non-liquefaction of gelatine; and acidity in litmus whey cultures varying from about 20 to 40 c.c. $\frac{N}{10}$ Na_2CO_3 per 100 c.c. of culture. The cane-sugar peptone and dulcit peptone tests may also be of value. As a matter of fact, in dealing with sewage and effluents and non-drinking water streams, I usually employ the first three, and when dealing with drinking water use as well the neutral-red broth and lactose-peptone tests. It is most imperative in doubtful and important cases to preserve the gelatine cultures for at least a fortnight to prove absence of liquefaction.

(4.) *Summary in relation to the presence of B. coli in drinking water and in sea water:—*

The water should primarily be assigned to its proper class. This is best achieved by the decimal mode of dilution‡ and the use of primary liquid cultures§ followed up by secondary gelatine plate cultures succeeded by isolation in *pure* culture‖ of the coli-like microbes. These pure cultures should take the form of gelatine "shake" cultures, and if gas formation takes place, this may, subject to the absence subsequently of liquefaction, be accepted as evidence of the presence of gas-forming, coli-like and probably objectionable microbes in this, that, or the other dilution or definite quantity of water. At this stage then a provisional numerical conclusion has been reached, and it remains to be seen whether this conclusion should be modified in view of any aberration as regards, for example, the indol, litmus milk, lactose-peptone and neutral-red broth tests.

If there is no evidence of loss or absence of attribute, the provisional numerical diagnosis is confirmed. But if on the other hand the coli-like microbe fails in one or more respects to give positive response when submitted to certain tests, the provisional numerical diagnosis suffers in value to a corresponding although indeterminate extent. This may seem in a sense indefinite, but it is remarkably precise when compared with conclusions based on mere conjecture. Bacteriological procedure of this kind gives at all events the number of gas-forming coli-like microbes; and it has been indicated already that, whereas no microbes of this sort are present in 100 c.c. of unpolluted sea water, their number in sewage may exceed 100,000 per c.c. Further, such tests serve to ascertain the characters of these

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* Whenever possible it is of great advantage to select as well microbes from the last-but-one and even the last but two dilutions yielding B. coli; these lower dilutions are apt naturally to contain the more typical races of B. coli.

† They are not arranged necessarily in the order of their utility.

‡ Of course, in the case of moderately pure water, dilutions are unnecessary. Here cultures should be made with 1, 10, and 100 c.c. of the water.

§ Strictly speaking, broth cultures should be used as free from inhibitory power of any kind. But the glucose, peptone, bile-salt medium is so useful in its negative aspects, and so relatively good in a positive sense, that its use may be recommended.

‖ This, of course, is *essential.*

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microbes, characters which would in cases of actual sewage pollution be found in the majority of instances to correspond to those belonging to the typical B. coli of the human intestine. No doubt, in certain cases, it would be necessary to examine *multiple* samples, and also to study in pure culture the biological characters of as many as possible of the coli-like microbes present in the water before coming to any definite conclusion.

In illustration of these observations the following tabular statement is given :—

CLASS.*	Standard based on numerical abundance of B. coli (or non-liquefying, gas - forming coli - like microbes).	Numerical standard confirmed or modified according to response of the coli-like microbes in *pure culture* to certain well-known biological tests.	Provisional bacteriological conclusions confirmed or modified by topographical observations.	Provisional bacteriological and topographical conclusions confirmed or modified by epidemiological and administrative considerations.
FIRST CLASS. A water showing no evidence (bacteriologically) of objectionable contamination.	No B. coli in 100 c.c.	For example :— (1) *Neutral-red broth test* — Greenish-yellow fluorescence (48 hours at 37° C.). (2) *Lactose peptone test*—Gas and acid production (48 hours. at 37° C.). (3) *Indol test*—Indol in broth cultures (5 days at 37° C.). (4) *Litmus milk test*—Acid clotting of milk (5 days at 37° C.). Of course, the more tests applied the better, but the above are all tests of known value. [*As regards tests* (1), (2), (3) *and* (4), *my work for the Local Government Board on the B. coli of recently-voided normal human fæces shows that of* 101 *B. coli*, 98, 92, 98, *and* 92 *per cent. respectively yielded positive results to one or other test. As regards all four tests (taken in conjunction)* 85 *per cent. yielded positive results.*]	For example:— Dilution; set of the tides; prevailing winds; float experiments; rate of flow; distance; time interval, etc.	For example:— Questions of practicability; whether the contaminating material is likely to have a high or a low enteric morbific value; past epidemiological experience in circumstances broadly parallel, etc., etc.
SECOND CLASS. A water showing appreciable, although slight evidence (bacteriologically) of objectionable contamination.	B. coli present in 100 c.c., none in 10 c.c.			
THIRD CLASS. A water showing definite signs (bacteriologically) of pollution, and therefore to be viewed with some degree of suspicion.	B. coli present in 10 c.c., none in 1 c.c.			
FOURTH CLASS. A water showing such obvious signs (bacteriologically) of objectionable pollution as to be condemned† on the basis of results.	B. coli present in 1 c.c., none in 0·1 c.c. (1 not 10).			
FIFTH CLASS.	B. coli present in 0·1 c.c. None in 0·01 c.c. (10 not 100).			
SIXTH CLASS.	B. coli present in 0·01 c.c., none in 0·001 c.c. (100 not 1,000). [Primary standard for sewage effluents; non-drinking water streams].			
SEVENTH CLASS.	B. coli present in 0·001 c.c., none in 0·0001 c.c. (1,000 not 10,000). [Secondary standards for sewage effluents; non-drinking water streams].			

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* It must, of course, be definitely understood that I am not prepared to say that a water of the third, second, or even first class is necessarily always "safe," much less that a water of the fourth, fifth, sixth or seventh class has a definite disease value.

† This does not mean necessarily administrative practical or legislative condemnation, but rather that the evidence of pollution is sufficiently defined to merit objection from the bacteriologist's point of view.

It is of advantage to take a hypothetical, although not unlikely instance to illustrate my meaning :—

The bacteriologist reports that an estuarial water in the region of shell-fish layings belongs to the third class, since it contains B. coli in 10 c.c., but not in 1 c.c. The B. coli isolated in pure culture give positive results with the neutral-red broth, lactose-peptone, indol and litmus milk tests. The conclusion is that the water should be viewed with some degree of suspicion, but not necessarily condemned.* And here, content with the exposition of facts, the bacteriologist leaves the matter to the topographist and epidemiologist.

The topographist points out that the sewage outfall is several miles above the layings, that the set of the tides and prevailing winds are favourable to dispersion of the sewage ; that the dilution of the sewage is seemingly great ; that float experiments appear to indicate that some days may elapse before a particle of sewage could pass from the outfall to the region of the shell-fish layings. He is, therefore, disposed conjecturally to consider the element of potential danger almost negligible, certainly not serious. Having regard to the bacteriologist's report, which, after all, is a statement of facts and a measure of the degree of excremental pollution, he might possibly, although improbably, suggest keeping the place under observation and furnishing the bacteriologist with further samples from time to time.

It is assumed, however, that the matter goes a stage further.

The epidemiologist might be prepared to agree with the topographist, but knows that the sewage at fault has probably a high enteric disease value, since the town sewered has suffered from typhoid fever in the past to a conspicuous extent. Moreover, question arose in connection with an epidemic of enteric fever in a neighbouring town as to whether the consumption of shell-fish obtained from the district in question was not in part responsible for the outbreak of disease. Under these circumstances the epidemiologist might conceivably be inclined to attach great weight to the bacteriological results, and even to place the layings under the ban of suspicion.

The above is a purely suppositional case, but it serves its purpose. Where pollution is patent and gross in character, danger is self-evident. Such cases form but a small proportion of the whole. In all other cases, it is well to take stock of our knowledge and ask by what means it is proposed to solve the problems which must inevitably arise in the future. Their partial solution need not, I think, be left entirely to posterity.

It has come within the writer's experience that in the case of the water of a contaminated estuarial river, which, from the result of his own topographical examination he would, in connexion with shell-fish layings, be apt to consider dangerously polluted, bacteriological examination of a multiplicity of samples showed that the water was by no means so impure as it had been tentatively adjudged to be. A consideration of the facts revealed by the quantitative and qualitative bacteriological estimation of the excremental bacteria present in the water in question would surely lead to a modification of the initial topographical conjecture.

Again, conversely, it has been the writer's experience in a case where preliminary topographical inspection led to no suspicion of appreciable excremental pollution, the result of bacteriological examination tended to create suspicion and suggested the desirability of further local inquiry, which, when pursued, yielded information if not wholly explanatory, tending, at all events, to modify somewhat his original impressions.

In the foregoing remarks I have set out a scheme for the classification of estuarial and sea waters in connection with shell-fish layings. It remains, however, to be seen how far even the moderate statements that have been made will bear the brunt of experience.†

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* Of course, some bacteriologists would absolutely condemn a water containing B. coli in 10 c.c. ; others would do so even if B. coli was present in 100 c.c. But at present, while the subject is on trial, moderate counsels should prevail.

† It may be surmised that in shallow and therefore often muddy water, the biological results frequently may be seemingly or actually anomalous in character.

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The B. enteritidis sporogenes test has not been considered here, but the results obtained by its use are none the less valuable. Probably the safest standard to suggest would be that a sample should yield a negative result when using 10 c.c. of the water for cultural purposes.

The first step has been taken by showing conclusively that unpolluted sea-water (near the surface) contains *no glucose fermenting coli-like microbes of any sort*[*] *in* 100 *c.c., nor spores of B. enteritidis sporogenes in* 10 *c.c.*

The next step is to show, in connection with the various shell-fish layings, to what class the surrounding water[†] would be assigned according to the suggested mode of classification. This may involve an inquiry too wide to be carried out *in extenso.*

So far, the results are not devoid of promise if the *average* results are taken as the guide, and if it be considered that tests may still be relatively very valuable, although falling far short of yielding absolute information. But if the worst results are taken from localities seemingly reasonably satisfactory on topographical observation, and compared with the best results from localities obviously polluted, the practical utility of the B. coli test may seem less obvious. Still further, if seemingly anomalous results are judged to be actually anomalous on the basis of mere conjecture, or because they cannot always be immediately explained, it is obvious that difficulties may at once arise.

Judged equitably, on a relative, not absolute basis, and considered as a means of diminishing the likelihood of error arising from topographical conjecture in all but obvious cases of gross pollution, the B. coli and other bacteriological tests deserve to be encouraged.

V.—Summarised conclusions.

In conclusion, it is desirable to emphasize very briefly the main points of this report. It is assumed that sewage pollution ought to be regarded as always potentially dangerous.

1. That B. coli and the spores of B. enteritidis sporogenes are absent from 100 c.c. and 10 c.c. respectively of multiple samples of unpolluted sea-water.
2. That B. coli and B. enteritidis sporogenes are commonly present in 1/100,000 c.c. and 1/100 to 1/1,000 c.c. respectively of sewage.
3. That taking into account both these extremes, estuarial waters, sea-water, and, indeed, water and liquids in general, may be divided *broadly* into nine classes by means of the B. coli test[‡].
4. That this division of waters into classes does not involve necessarily the difficult question of absolute standards, but it may be convenient to condemn or object to a water of the fourth class (+1, - ·1 c.c.); regard with some degree of suspicion a water of the third class (+ 10, - 1 c.c.); consider not wholly free from evidence of probably objectionable pollution a water of the second class (+ 100, - 10 c.c.); and unconditionally on the basis of results approve a water of the first class (negative 100 c.c.).

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[*] Some stress may be laid on the expression "of any sort," because it is constantly being contended that, as bacteriologists are not in complete agreement as regards what constitutes typical B. coli, the present practical utility of the B. coli test is *sub judice.* Such contentions are not justifiable. The B. coli test already is second to none as a measure of the degree of excremental pollution; it only remains to discover whether by continued research its practical usefulness may not be still further enhanced.

[†] The surrounding water before and *after* the subjacent mud has been stirred up into it, on theoretical grounds should be considered. But, practically speaking, it would be difficult to stir the subjacent mud in such a way as to yield in all cases a uniform, and therefore comparable, mixture of water and mud. The mud question is of great importance, but this report primarily is concerned only with water collected at or near the surface.

[‡] Negative 100 c.c.; + 100, — 10 c.c.; + 10, — 1 c.c; +1, — ·1 c.c.; + ·1, — ·01 c.c.; + ·01, — ·001; + ·001, —·0001; + ·0001, — ·00001; + ·00001. First, second, third, fourth, fifth, sixth, seventh, eighth, and ninth classes respectively. It is obvious that these classes may be subdivided further, but whether or not this is desirable at present is a moot point. For example, we may subdivide the second class according to whether a positive result is yielded with 90, 80, 70, 60, 50, 40, 30, or 20 c.c. of the sample. Such subdivision might be expressed by the term sub-class, 1, 2, 3, 4, 5, 6, 7, 8, or 9 respectively. The same principle applies to the other classes.

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5. That B. coli, artificially added to unpolluted sea-water and to tap water speedily loses its vitality or, at all events, becomes greatly diminished in number under laboratory conditions of experiment. The continued persistence of B. coli *in any number* in estuarial waters may be traced to continuous excremental pollution and the presence of unoxidised organic pabulum in the water.
6. That neither the epidemiologist, nor the topographist, nor even the bacteriologist can assign a definite "disease value" to a given pollution.
7. That conclusions as regards the *degree* of potential danger to health arising from sewage pollution must, if sound, be based consciously or unconsciously on an assumed or real knowledge of the amount of fresh sewage matters present in the water, and more particularly on the number of living microbes of *recent* intestinal origin.
8. That there appear to be three ways of estimating *degrees of pollution.* The topographical or inferential method * ; the chemical or indirect (*qua* microbes) but broadly useful method † ; and the bacteriological or seemingly most direct method. §
9. That in all but obvious cases of contamination *degrees* of pollution need to be measured by the bacteriologist, *who should interpret his results in the light of local observations and epidemiological considerations.*
10. That however well-balanced the representations of the topographist may be as regards estuarial pollution, they are expressions of opinion involving in large measure the personal equation, and if uninfluenced by quantitative and qualitative bacteriological data, may be lacking in comparative value, and may therefore be inconclusive.

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* In the sense indicated here the topographical method theoretically is mainly speculative in character. But having regard to the breadth of its operations, it may be, and indeed is actually, of *signal and indispensable value in practice.*

† The chemical method is a definite and extremely accurate method, and although indirect in character, may, within certain limits and in certain directions, yield most valuable results.

§ The bacteriological method is direct *qua* numerical estimation of intestinal microbes, but indirect as regards disease-producing bacteria. Although seemingly the best method, and extremely delicate, it is nevertheless to be thought of as of relative, not absolute, value.

DIVISION IV.

The Bacteriological Examination of Samples of Water and of Oysters obtained from the Helford and Penryn Rivers (Cornwall).

DIVISION IV.

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Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

THE BACTERIOLOGICAL EXAMINATION OF SAMPLES OF WATER AND OF OYSTERS OBTAINED FROM THE HELFORD AND PENRYN RIVERS (CORNWALL).

This report deals with the quantitative and qualitative bacteriological examination of water and oysters obtained from two rivers in Cornwall, not far distant from each other topographically, but widely different as regards their local surroundings.

The Helford River traverses a sparsely-populated district, and ranks as one of the purest localities in England for the growth and fattening of oysters.

The Penryn River is polluted, and its oyster layings lie under the ban of suspicion.

It is beyond question that the Helford River, from the point of view of the topographist and epidemiologist, would be approved. It is equally certain that the Penryn River, on topographical and epidemiological grounds, would be regarded with great suspicion, if not condemned.

The primary object of this investigation was to compare, bacteriologically, the water and oysters from these two rivers.*

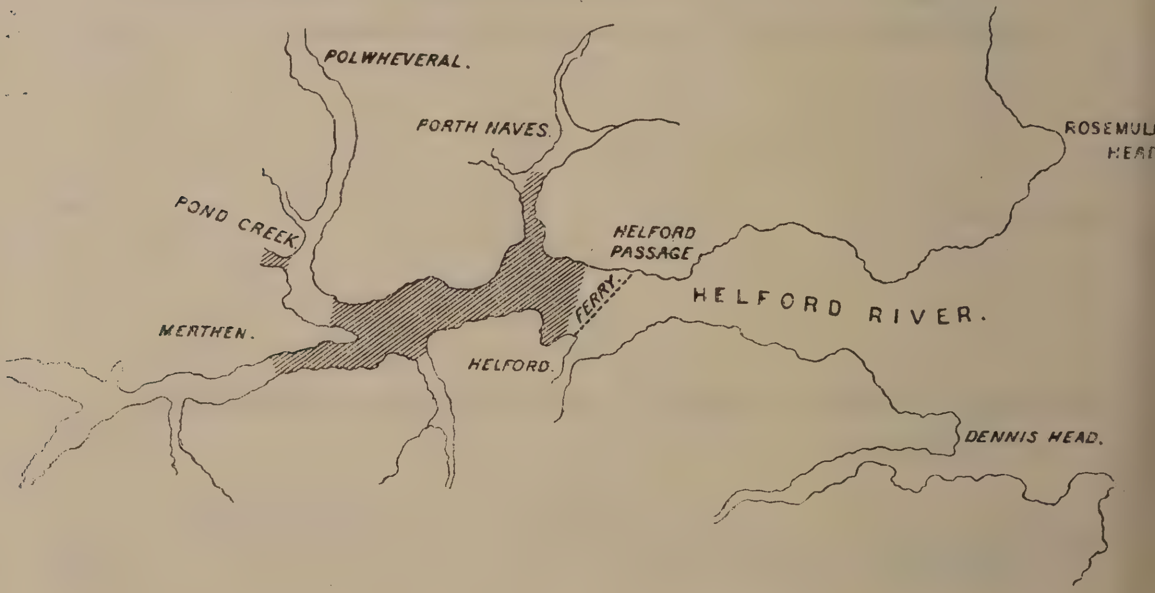
PART I.

HELFORD RIVER (CORNWALL).

The Helford River is situated on the South Coast of Cornwall, West of Falmouth, and opens into the English Channel between Rosemullion Head and Nare Point (*see* Maps 1 and 2).

Its importance from the point of view of this report is due to the fact that, to quote from Dr. Bulstrode's report†, it

> "yields a prolific supply of oysters of native growth."......... "The most productive portion "of it."......... "extends from just below Merthen Quay to near Helford Ferry, embracing "parts of Polwheverral and Porth Navas Creeks."



The dark portion indicates position of oyster layings. (From Dr. Bulstrode's report.)
One inch to one mile.

The greater part of the oyster trade in the neighbourhood is worked by an old family (Tyacke) for many years resident in the district.‡

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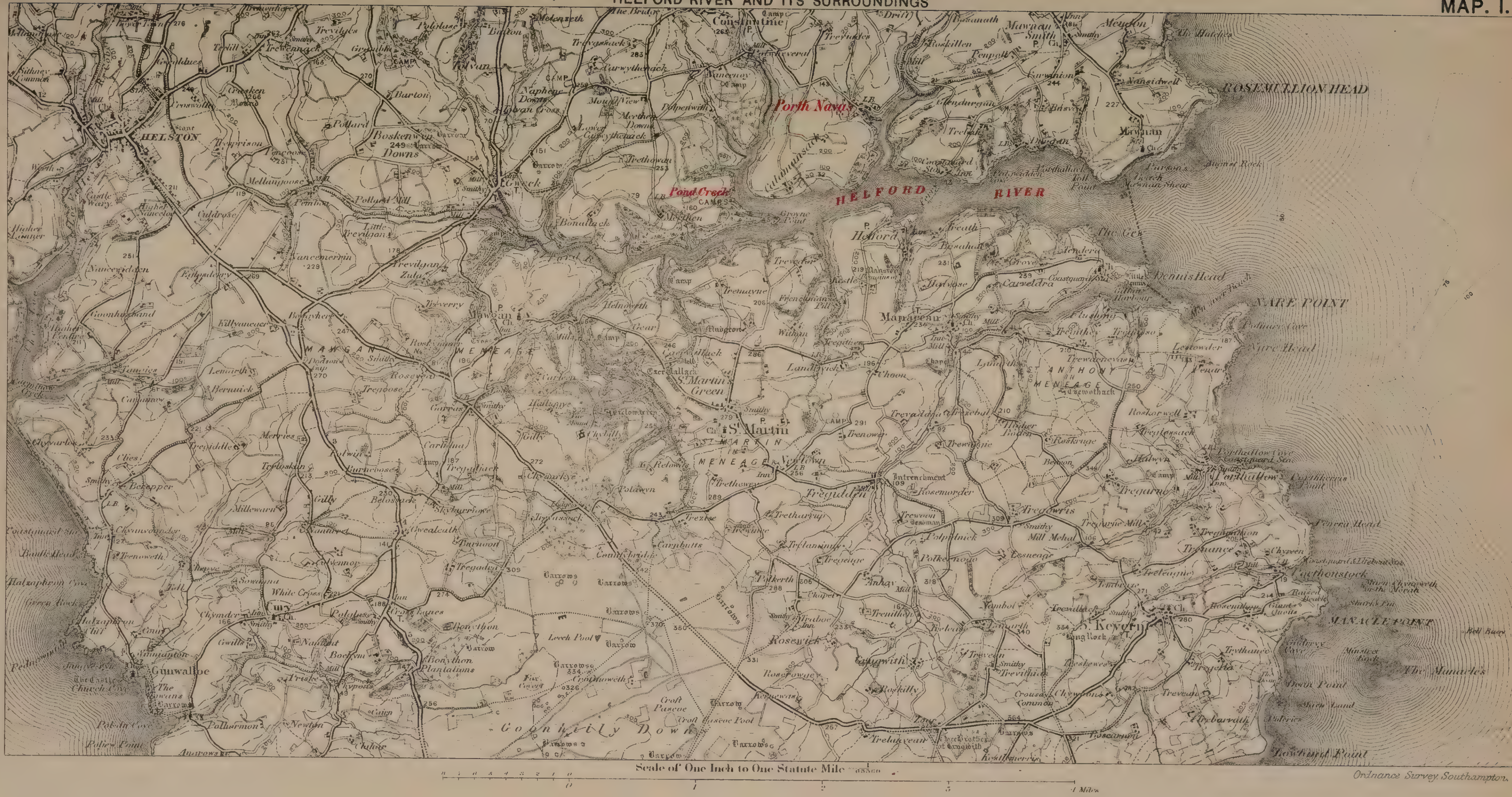
* A tribute of praise should be accorded to the valuable work of Dr. McWeeney. He received numerous samples of water, shell-fish, and mud, for bacteriological examination, from Drs. Browne and Flinn, Medical Inspectors to the Irish Local Government Board, *without any accompanying knowledge of the local conditions.* Despite this limitation, his bacteriological results and conclusions supported, generally speaking, the conclusions arrived at by Drs. Browne and Flinn as the result of their topographical observations.

† Report of the Medical Officer Local Government Board 1894-5, Supplemental Report on Oyster Culture in relation to Disease; By Dr. Bulstrode.

‡ Of late years a portion of the fishery has been leased to Mr. Kitto.

HELFORD RIVER AND ITS SURROUNDINGS



Ordnance Survey, Southampton.

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

The oysters are dredged up from the estuary and laid down in Porth Navas Creek on a cemented bottom. From thence they are conveyed to a storehouse at Stonehouse Pool, Plymouth, and are supplied subsequently to the market as occasion demands.

The local conditions are thus described by Dr. Bulstrode.

> "The Helford river and the 'Creeks' abutting upon it traverse an almost unpopulated, and "for the most part thickly wooded, country ; there are no sewers entering it hereabouts."......... "indeed, the estuary appeared to me, from the view point of this enquiry, to be well fitted for "the preparation of oysters for market."

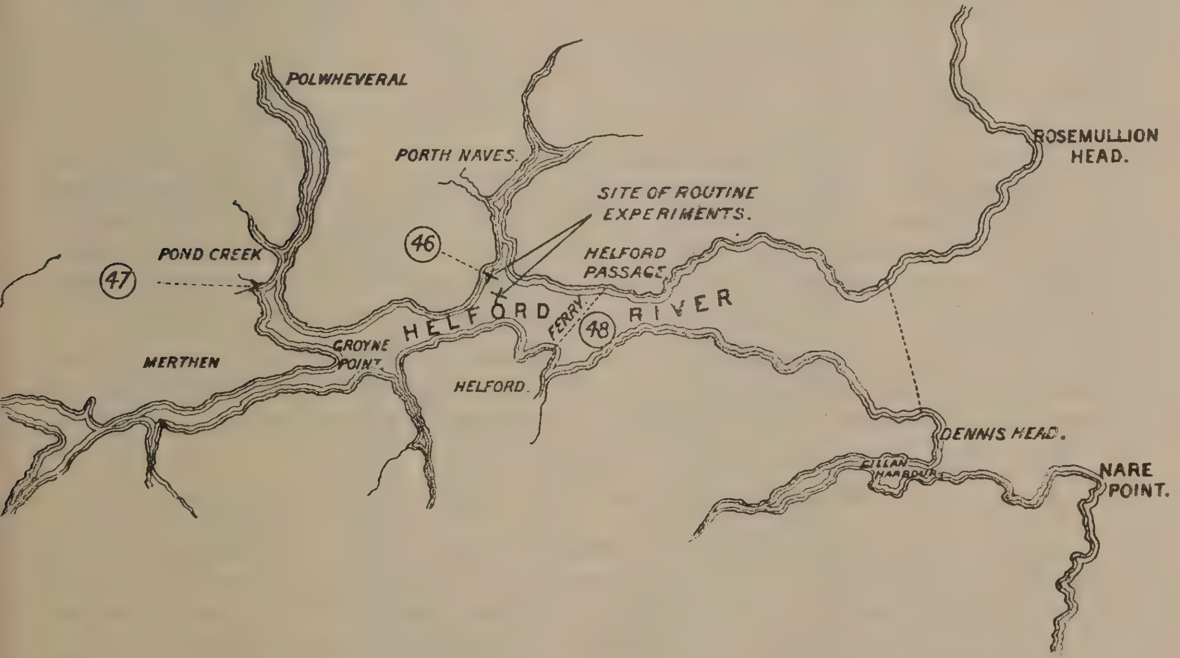
The above description of the local surroundings has, it is believed, never been questioned.

It may indeed be the case that the Inn and Coastguard Station on the Falmouth side of Helford Passage and Helford on the opposite side; Constantine and neighbouring hamlets in connection with Polwheverral Creek; and Gweek, and possibly other places in relation to the upper reaches of the Helford River combine to pollute the Helford estuary to a minor extent.

Probably also the yachts, which in the summer months are fairly numerous in the region of Helford Passage, play a localised part in contaminating the water.

Nevertheless, it is impossible to escape the conviction that Dr. Bulstrode's description of the estuary is substantially correct. It certainly agrees with my own conceptions in the matter. While the bacteriological results do not altogether tally with the topographical evidence with regard to the Helford River, it is not sought on this account to impugn a locality in vindication of the ascertained biological facts. On the contrary, it may be admitted that some of the bacteriological results are seemingly not in complete harmony with the incomplete topographical observations which opportunity afforded the writer, and the much more reliable investigations of Dr. Bulstrode.

Preliminary Work:—On April 25th 1903, a visit was paid to the Helford River, and samples of water collected for bacteriological examination. The approximate sites of collection are shewn on the following plan :—



The following is a description of the water samples :—

Sample 46. April 25th 1903. About high tide. Boat sample collected over the Tyacke oyster layings in Porth Navas Creek.

Sample 47. April 25th 1903. Tide, about one-sixth ebb. Boat sample collected over the Kitto oyster layings in Pond Creek.

Sample 48. April 25th 1903. Tide about one-sixth ebb. About midway between Helford Passage and Helford.

As regards the bacteriological examination of the samples, the following results were obtained :—

None of the three samples contained any coli-like microbes of any sort in 10 c.c.

The B. enteritidis sporogenes test yielded also negative results* when using 10 c.c. of the waters for cultural purposes.

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* Sample 48 did not give an absolutely negative result, but the appearances of the culture were atypical, and so perhaps the result is best recorded as negative.

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These preliminary negative results are in *complete agreement* with the *topographical features* of the Helford River. Unfortunately, in work undertaken later in the year, the results were not always of so satisfactory a nature.

On April 27th 1903, a visit was paid to the Storehouse at Stonehouse Pool, Plymouth.

As it was low water at the time, the Storehouse was empty, but this fact enabled an investigation of its interior to be made. The floor is cemented, and so also are the sides for several feet up to nearly the level of the opening on the wall looking out on Stonehouse Pool. The arrangement is such that the tide is about $\frac{2}{3}$ flood (presumably approaching to its purest condition) before the water begins to enter in bulk by the aforesaid opening, and fill the chamber. Facilities, of course, are provided also for emptying the chamber.

On the floor of the chamber is a square well a few feet deep. This enables the man in charge to clean the floor at low water, and when the chamber is empty.

The chamber is entered by a stone flight of steps. On the occasion of my visit the floor and steps and sides of the chamber looked perfectly clean, but the water in the well, when the mud at the bottom was forcibly disturbed with a rake, became black and offensive looking, and malodorous gases were given off. The man in charge, however, explained that owing to the depression in the oyster trade it had not been quite recently emptied, and promised, in future, to remove this possible source of objection, by frequent and periodic cleansing. On descending the flight of steps leading to the chamber some hens were disturbed, which had taken advantage of their freedom and the state of the tide to explore the interior. No doubt this was an accidental circumstance, and doubtless precautions will be taken in the future to prevent its recurrence.

A sample (No. 50) was collected from Stonehouse Pool, opposite the Royal Navy Victualling Yards, on this date from a boat and at about low water.

It contained B. coli in 1 c.c., but not $\frac{1}{10}$ c.c.*; and B. enteritidis sporogenes in 10 c.c., but not in 1 c.c.

On May 1st 1903, a sample of water was sent me from the Storehouse taken when the tide was about two-third flood.

It contained B coli† in $\frac{1}{10}$ not $\frac{1}{100}$ c.c., B. enteritidis sporogenes was present in 1 c.c., but not $\frac{1}{10}$ c.c.

A consideration of the above facts inevitably suggests the conclusion that the Helford oysters are grown and fattened in a most favourable locality, but that subsequently they are stored for market in a situation and under conditions which can hardly be described as satisfactory.‡

Until August 1903, pressure of other work for the Commission held the Helford investigation in abeyance. Observations were then started anew, and the oysters, as well as the water, were subjected to routine bacteriological investigation.

Routine work:—

On August 17th 1903, a second visit was paid to the Helford River. At this early stage of the oyster season, the oysters had not been dredged from the Main Channel and laid down in Porth Navas Creek. Up to the end of August the samples both of water and oysters were taken from the main channel, opposite Porth Navas Creek. Afterwards the low water samples, both of oysters and of water, were collected from Porth Navas Creek.

The results of the examination of the channel water and oysters collected on this date, will be found in the general tables, but here may be given the results of the analysis of a sample of water collected from Porth Navas Creek.

The water contained B. coli§ in 100 c.c. but not 10 c.c.

The B. enteritidis sporogenes test gave a negative result with 10 c.c.

Before proceeding to give a detailed account of the routine work, it is necessary to make some explanatory remarks, as regards the B. coli and B. enteriditis sporogenes tests, and on the methods used in the investigation.

As these remarks are of a technical nature the general reader may pass on to page 120.

Explanatory remarks as regards the B. coli results:—

As regards the B. coli results it is to be noted that the numerical figures

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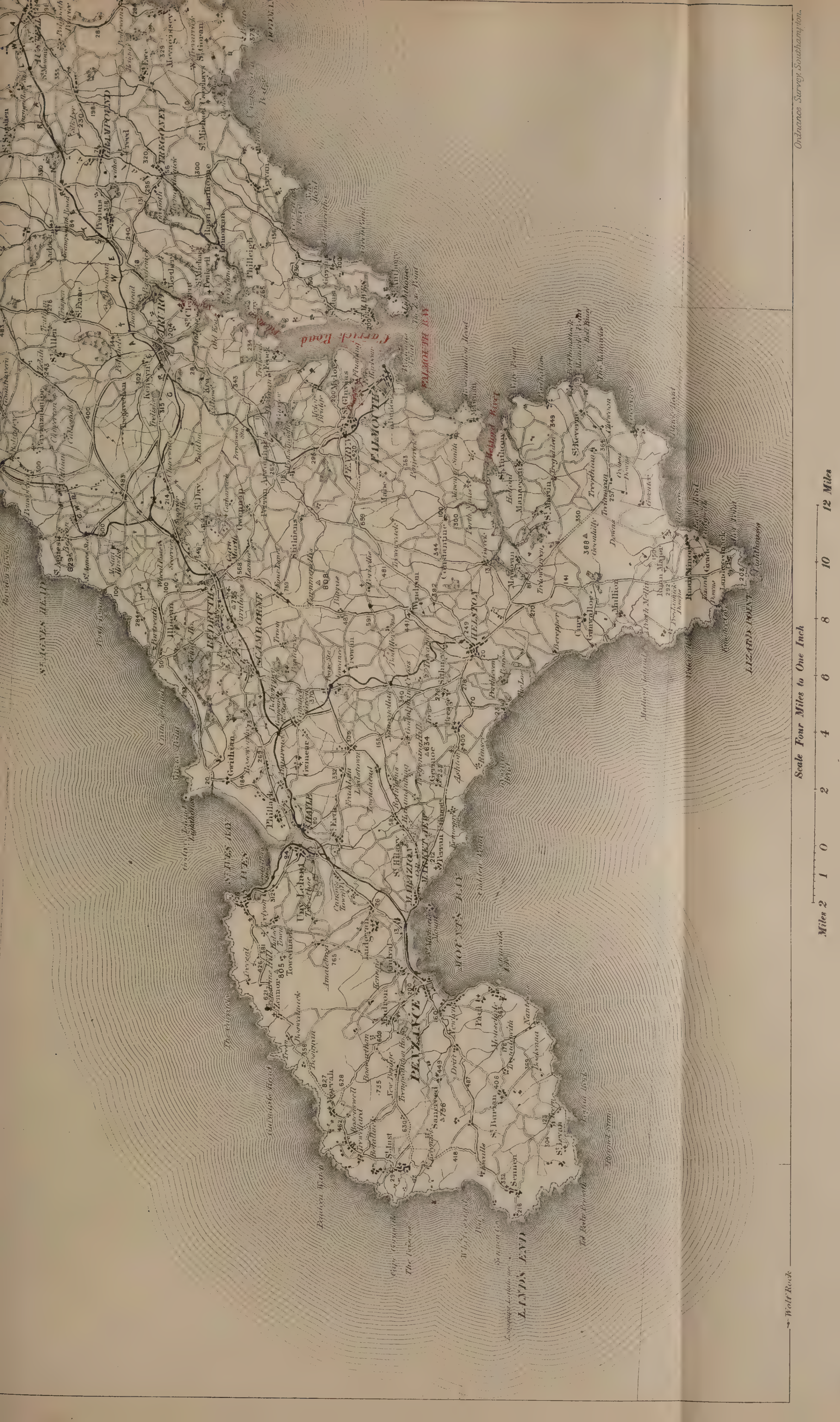
* The strain of B. coli produced acid and clot in milk and indol in broth culture.

† The strain of B. coli produced acid and clot in milk and indol in broth culture.

‡ Since this report was written I have been informed that the Helford oysters are now sent direct to market from the Helford River. The foregoing description is retained, however, as it teaches the useful lesson that an oyster may be grown and fattened under seemingly almost ideal conditions and subsequently stored under conditions the reverse of satisfactory.

§ The strain of B. coli gave positive results with the following tests: lactose peptone (acid and gas); neutral-red broth (fluorescence); broth (indol); and litmus milk (acid and clot).



Ordnance Survey, Southampton.

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are based on the isolation in *pure* culture of a *coli-like* microbe which gave "gas" in gelatine "shake" cultures. Whether or not it was completely typical is a separate question, but as in each case the full details are given it is open to anyone to draw independent conclusions from the results. Further, the biological characters of the *strain* of B. coli derived from the last dilution-but-one yielding coli-like microbes are also given, because it sometimes happens that a coli-like microbe isolated from a "last dilution" culture and failing in one or more respects is accompanied in the "last dilution-but-one" culture by completely typical B. coli. Unfortunately, however, this is by no means always the case, and indeed sometimes the reverse condition is observed, *i.e.*, the "last dilution" culture yields more typical B. coli than the "last dilution-but-one" culture. It may be asked why the figures are not based on the number of *completely typical* B. coli? This is a difficult question to answer without involving the detailed consideration of many technical points and problems of considerable complexity. It needs always to be remembered that colonies of coli-like microbes in plate culture may be to the eye indistinguishable from those of typical B. coli and yet the colony selected for sub-culture may be found subsequently to fail in one or more respects, *e.g.*, indol production. There is no hall-mark peculiar to a colony of *typical* B. coli which enables the bacteriologist to anticipate the results of sub-culture. It is obvious, therefore, that the speculative choice of colonies may sometimes be unfortunate and that the bacteriologist may find himself in the position of being unable to condemn a sample, although swarming with coli-like microbes, because none of those colonies subcultured fulfilled each and every one of arbitrary conceptions of what constitutes the typical B. coli. Domestic sewage is rich in coli of this aberrant sort, and in this connexion I may cite an experiment carried out in 1898.

10 c.c. of gelatine were poured into a sterile gelatine plate. After the gelatine had solidified it was inoculated with $\frac{1}{100000}$ c c. of Crossness crude sewage; and the material spread over the surface with a sterile instrument.

75 colonies developed; 15 of these colonies were indistinguishable from those of typical B. coli on naked-eye examination when magnified with a hand lens and when viewed under a low power of the microscope. Microscopic preparations were made from all the 15 colonies. The bacteria were coli-like and motile in each instance. All gave "gas" in gelatine "shake" cultures within 24 hours at 20° C.

As regards litmus milk cultures by the 6th day (at 37° C.), microbes Nos. 6 and 10 alone showed clotting (6 commencing clot, 10 solid clot), and the rest presented appearances indicating great variation in the degree of acidity produced. All gave a "diffuse cloudiness" appearance in broth cultures within 24 hours at 37° C., but on the 6th day all, with the exception of microbe No. 6, gave a negative result as regards indol production.

In other words, only 1 out of 15 gave gas, acid and clot, and indol in gelatine "shake," litmus milk, and broth cultures respectively. Indeed the clotting of the milk was not well marked, so that in a sense it may be said that none of the coli-like microbes were completely typical of B. coli *communis* so-called.

Now to the extremist this means that the sample (sewage) could not be condemned on the basis of the B. coli test because, although it contained 1,500,000 gas-forming coli-like microbes per c.c., none of the 15 selected for subculture could be said to be *typical* B. coli.

The foregoing example is doubtless an extreme instance, but it serves well to illustrate my meaning.

If the significance of the presence of gas-forming coli-like microbes be denied, and evidence of objectionable pollution be limited to the presence of microbes yielding within an arbitrary period *all* the tests considered characteristic of typical B. coli, then it may be said, with confidence, that many waters will, in practice, escape condemnation, although known to be seriously polluted with sewage and shown on bacteriological examination to be *rich* in *coli-like* microbes.

Safety, surely, lies in pitting number against characters. That is, the greater the number of coli-like microbes, the less need be the insistance on their fulfilling all the known tests for typical B. coli. Conversely, the more typical the characters of the B. coli chosen for subculture the greater the justification for stringent standards as regards numerical abundance.

In order to give a continuous *quantitative* record it is necessary to have

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

some basis, and the basis in this, as in previous reports, is the number of B. coli or coli-like microbes which, when isolated in *pure* culture, yield gas in ordinary gelatine* "shake" cultures. The microbes are next subcultured in various media and the results placed on record. If the results are completely positive, the preliminary numerical diagnosis is fully confirmed. But if, on the other hand, the coli-like microbe fails in one or more respects to respond positively to the tests employed, the provisional numerical diagnosis suffers in value to a corresponding, although indeterminate extent. It is impossible to suggest any formula to link together number and character. Even if it were possible to assign an exact relative value to each separate test for differentiating from coli-like microbes of saprophytic sort or of remote intestinal outcome, B. coli of *recent* intestinal origin, it is difficult to see how the results could be utilised as a factor for dividing the quantitative results. It might be imagined that a knowledge of the biological attributes of a hundred individual B. coli, *e.g.*, isolated from the human intestine would supply the data necessary for such a calculation. These records will shortly be published by the Local Government Board, but they afford no real solution of the problem. It is true that they will give the percentage number of these hundred individual fæcal B. coli that respond to each of a large number of biological tests and their relative abundance in the several fæces of experiment. But except by inference it is impossible to forecast whether or not such microbes are able to retain their intrinsic biological attributes in full measure when sometime dissociated from the animal body and so long as their vitality lasts. Nor have we knowledge of the relation, under saprophytic conditions, of typical B. coli and coli-like microbes, as regards normal death and as to possible birth rate. It must perforce be concluded that as in sewage and sewage polluted waters, coli-like microbes abound which are not in all respects completely typical of the B. coli freshly voided from the human intestine, and as there are no means, except by an impracticable series of subcultures, of sifting the aberrant strains from their more typical brethren, it is permissible primarily to regard all coli-like microbes as indicative of the presence of undesirable material, and secondarily to guard this position by a detailed account of the attributes of the implicated microbes. There is the more reason to adopt this attitude since in multiple samples of pure fresh water and sea water coli-like microbes of any sort are absent from 100 c.c. of the sample. Indeed, in isolated samples, the test has yielded negative results even with 1,000 c.c.

The above is no mere digression but has a direct and important bearing on the whole of the present enquiry.

It must, therefore, be understood that throughout this report the numerical results are based on the number of gas-forming coli-like microbes of all sorts, but that in each case the biological attributes of the microbes in question are given in detail.

Explanatory remarks as regards the B. enteritidis sporogenes test:—

It is to be noted that throughout this investigation no animal inoculation experiments were made in this connection. It has been shewn in previous reports that the B. enteritidis sporogenes test, *as a test,* is of considerable practical utility apart from the inoculation of rodents, provided always that the test is used quantitatively. The value of the test in the present enquiry will, it is believed, be apparent when all the results are brought into comparison.

METHODS.

The method used in the bacteriological examination of the oysters is dealt with in Addendum A. The examination of the waters was conducted broadly on the lines laid down in previous reports. It should be noted that all the facts are set forth in great detail. Hence, if the inferences and conclusions be regarded as open to criticism, the record of facts remains still available

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* When the gelatine medium is prepared in such a way as not to readily yield gas with coli-like microbes, it should be fortified with glucose. No brew of gelatine medium, however, that has been employed, has ever failed to be entirely satisfactory in this respect. Practically speaking, the results obtained with the ordinary gelatine medium, as used by me, coincide with the results obtained with glucose gelatine.

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for fresh interpretations and altered inferences. At the same time it is obvious, that the more frank and detailed the statement of bacteriological results the greater is opportunity afforded for petty as well as *bonâ-fide* criticism. This, however, is a small matter, the object of the investigation being to reveal the truth as regards the bacteriological aspects of the oyster question, so far, indeed, as this was possible within the narrow compass of time the Commission was able to allocate to the enquiry.

It is of advantage to consider in the first place the results of the bacteriological examination of the water over the oyster layings.

TABLE I.

Showing the Results of the Bacteriological Examination of the Helford River Water over the Oyster Layings (*see* Diagrams 1 and 2).

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

TABLE 1, showing the Results of the Bacteriological

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.							
No.	Time of Collection.				Other Details.	+ 100 c.c.	+ 10 c.c.	1	10	100	1,000	10,000	100,00
	Tide.	Day.	Month.	Year.				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1	Low	17	8	1903	Helford river water over oyster layings.		+	− Characters of the coli from the 100 c.c. cultur					
2	High	18	8	1903	Helford river water over oyster layings.		+	− Characters of the coli from the 100 c.c. cultur					
3	Low	18	8	1903	Helford river water over oyster layings.	+	−						
4	High	19	8	1903	Helford river water over oyster layings.		+	− Characters of the coli from the 100 c.c. cultur					
5	Low	19	8	1903	Helford river water over oyster layings.	+	−						
6	Low	24	8	1903	Helford river water over oyster layings.			+ Characters of the coli from the 10 c.c. culture	−				
7	High	24	8	1903	Helford river water over oyster layings.			+ Characters of the coli from the 10 c.c. culture	−				
8	High	25	8	1903	Helford river water over oyster layings.			+ Characters of the coli from the 10 c.c. culture	−				
9	Low	25	8	1903	Helford river water over oyster layings.			+ Characters of the coli from the 10 c.c. culture	−				
10	Low	26	8	1903	Helford river water over oyster layings.		+	− Characters of the coli from the 100 c.c. culture					
11	High	26	8	1903	Helford river water over oyster layings.	+	−						
12	High	31	8	1903	Not received.								
13	Low	31	8	1903	Helford river water over oyster layings.	+	−						
14	Low	1	9	1903	Helford river water over oyster layings.	+	−						
15	High	1	9	1903	Helford river water over oyster layings.		+	−					
16	High	7	9	1903	Helford river water over oyster layings.	+	−						
17	Low	7	9	1903	Helford river water over oyster layings.		+	− Characters of the coli from the 100 c.c. culture					
18	High	8	9	1903	Helford river water over oyster layings.		+	− Characters of the coli from the 100 c.c. culture					
19	Low	8	9	1903	Helford river water over oyster layings		+	− Characters of the coli from the 100 c.c. culture					

Examination of the Helford River Water over the Oyster Layings.

3.						4.						5.
Chief Biological Characters of the strain of B. coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anaerobic milk cultures). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium. + = Acid and gas, 48 hours at 37° C.	Neutral-red broth cultures. + = Greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(a)	(b)			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+ N.L.	+	+	+	+	–			Negative 10 c.c.				N.L. signifies no liquefaction one month.
+ N.L.	+	+	+	+	?+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				S.L. signifies slow liquefaction.
+ N.L.	+	+	+	+	+							
+ S.L.	–	+	–	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	–	+	+							
+ N.L.	+	+	–	+	+			Negative 10 c.c.				
+ N.L.	+	+	–	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ S.L.	–	+	+	+	–							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	–	+	+	+	+			Negative 10 c.c.				
+ N.L.	–	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	–	–	–	–	–			Negative 10 c.c.				
+ N.L.	–	+	–	?+	+							
+ N.L.	–	+	–	–	–			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

TABLE 1, showing the Results of the Bacteriological Examination

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in1 c.c.							
No.	Time of Collection.				Other Details.	+ 100 c.c.	+ 10 c.c.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
20	High	21	9	1903	Helford river water over oyster layings.			+ Characters of the coli from the 10 c.c. culture	–				
21	Low	21	9	1903	Helford river water over oyster layings.	+	–						
22	Low	22	9	1903	Helford river water over oyster layings.			+ Characters of the coli from the 10 c.c. culture	–				
23	High	22	9	1903	Helford river water over oyster layings.			+ Characters of the coli from the 10 c.c. culture	–				
24	High	28	9	1903	Helford river water over oyster layings.		+	– Characters of the coli from the 100 c.c. culture					
25	Low	28	9	1903	Helford river water over oyster layings.		+	– Characters of the coli from the 100 c.c. culture					
26	Low	29	9	1903	Helford river water over oyster layings.			+ Characters of the coli from the 10 c.c. culture	–				
The numbers of the samples as regards waters and oysters are in correspondence.						7 out of 25, 28 per cent.	10 out of 25, 40 per cent.	8 out of 25, 32 per cent.					

of the Helford River Water over the Oyster Layings—*continued.*

	3.						4.						5.
	Chief Biological Characters of the strain of B. coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis changes" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						Remarks.
	Gas (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium. + = Acid and gas. 48 hours at 37° C.	Neutral-red broth cultures. + = Greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
			(*a*)	(*b*)			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
	+ N.L.	+	+	–	+	+	Negative 10 c.c.						N.L. signifies no liquefaction one month. S.L. signifies slow liquefaction.
	+ N.L.	+	+	–	+	+							
	+ N.L.	+	+	+	+	+	Negative 10 c.c.						
	+ N.L.	+	+	+	+	+	Negative 10 c.c.						
	+ N.L.	+	+	–	–	–							
	+ N.L.	+	+	+	+	+	Negative 10 c.c.						
	+ N.L.	+	+	+	+	+							
	+ N.L.	+	+	+	+	+	Negative 10 c.c.						
	+ N.L.	+	+	+	+	+							
	+ N.L.	+	+	+	+	+	Negative 10 c.c.						
	+ N.L.	+	+	+	+	+							
	+ N.L.	+	+	+	+	+	Negative 10 c.c.						
	+ N.L.	+	+	+	+	+							
the numerical results.	All positive, 100 per cent.	35 out of 42 positive, 83·3 per cent.	41 out of 42 positive, 97 per cent.	32 out of 42 positive, 76 per cent.	39 out of 42 positive, 92 per cent.	37 out of 42 positive, 88 per cent.	All the samples gave a negative result with 10 c.c.						
Inclusive of all the results.	All positive, 100 per cent,	21 out of 25 positive, 84 per cent.	24 out of 25 positive, 96 per cent	20 out of 25 positive, 80 per cent.	23 out of 25 positive, 92 per cent.	22 out of 25 positive, 88 per cent.							

N.L. Column 3 signifies no liquefaction of gelatine (one month).
S.L. ,, ,, ,, slow ,, ,, ,, ,, ,,

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

Results as regards the presence of B. coli in the Helford water over the oysters.

The results shown in Table 1 and Diagram 1 may be briefly summarised as follows :—

7 out of 25 samples (28%) contained B. coli or coli-like microbes in 100 c.c., but not in 10 c.c.

10 out of 25 samples (40%) contained B. coli or coli-like microbes in 10 c.c., but not 1 c.c.

8 out of 25 samples (32%) contained B. coli or coli-like microbes in 1 c.c., but not 0·1 c.c.

As regards the biological attributes of the coli-like microbes, it may be said that the percentage number yielding positive response to each individual test and to the tests collectively, was great. Apart from topographical, questions the results *per se* suggest somewhat strongly that, although the pollution was *small in amount*, it was *recent* in character, and of intestinal outcome. It will presently be noted that a far larger proportion of the coli-like microbes isolated from the oysters were, in one or more respects, atypical than was the case as regards the water over the oysters. It is difficult to explain this circumstance, unless on the assumption that, as regards the oyster, one was dealing in part with coli-like microbes peculiar to the oyster, or that B. coli is capable of persisting in atypical form in the oyster, or in the mud on which these molluscs lie.

Results, as regards the presence of B. enteritidis sporogenes in the water over the oysters. (Table 1 and Diagram 2.)

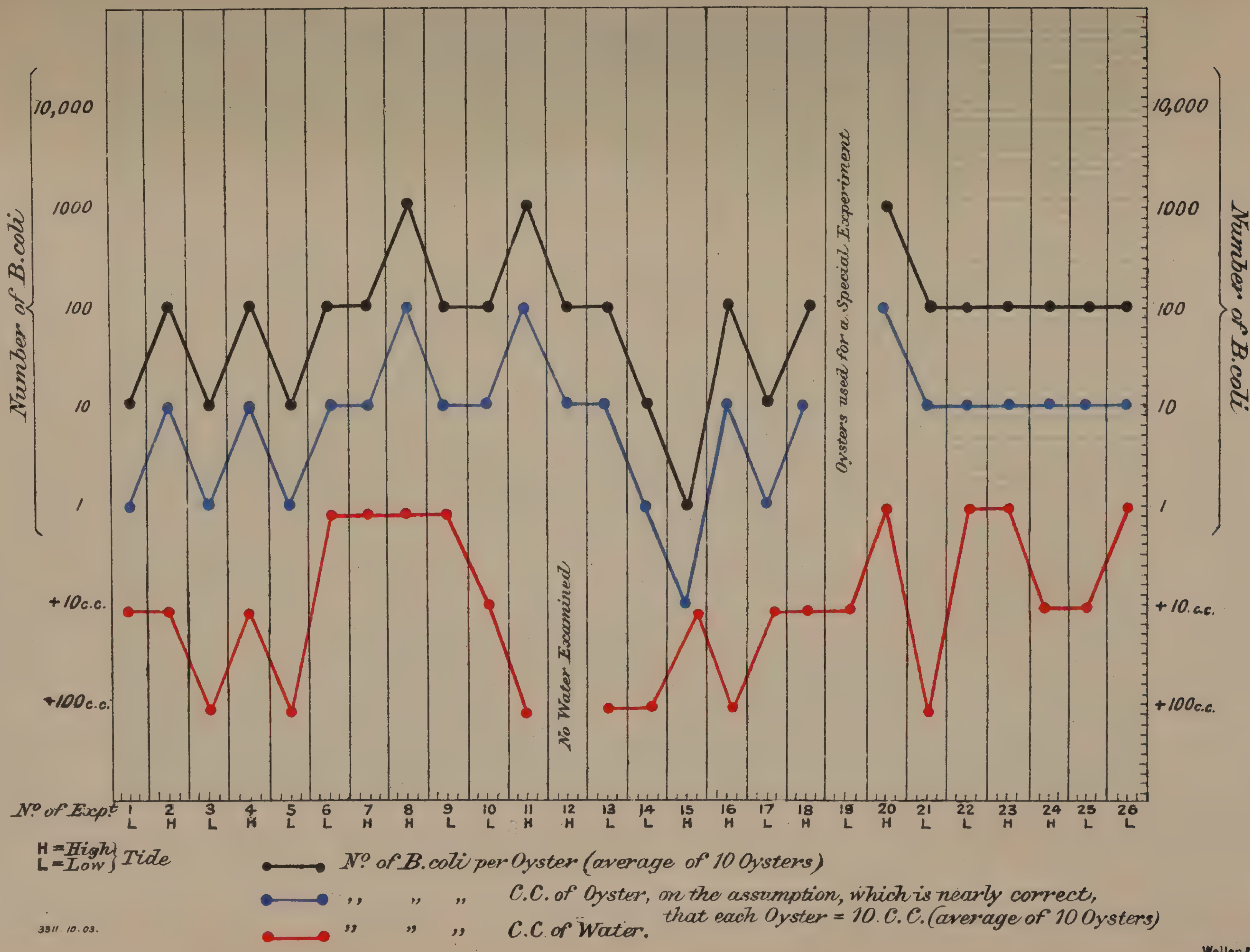
The results were satisfactory, since none of the samples yielded a positive result when using 10 c.c. of the sample for cultural purposes.

The following is a brief summary of the chief bacteriological results :—

B. Coli or coli-like Microbes.			B. Enteritidis Sporogenes.
100 c.c.	10 c.c.	1 c.c.	10 c.c.
Positive result	Positive result	Positive result	Negative result
28%	40 %	32 %	100 %

The results of the Bacteriological Examination of the Helford oysters may next be considered. (Table 2).

Diagram I, showing, as regards B.coli, the results of the Bacteriological
Examination of samples of Water & Oysters obtained from the Helford River.



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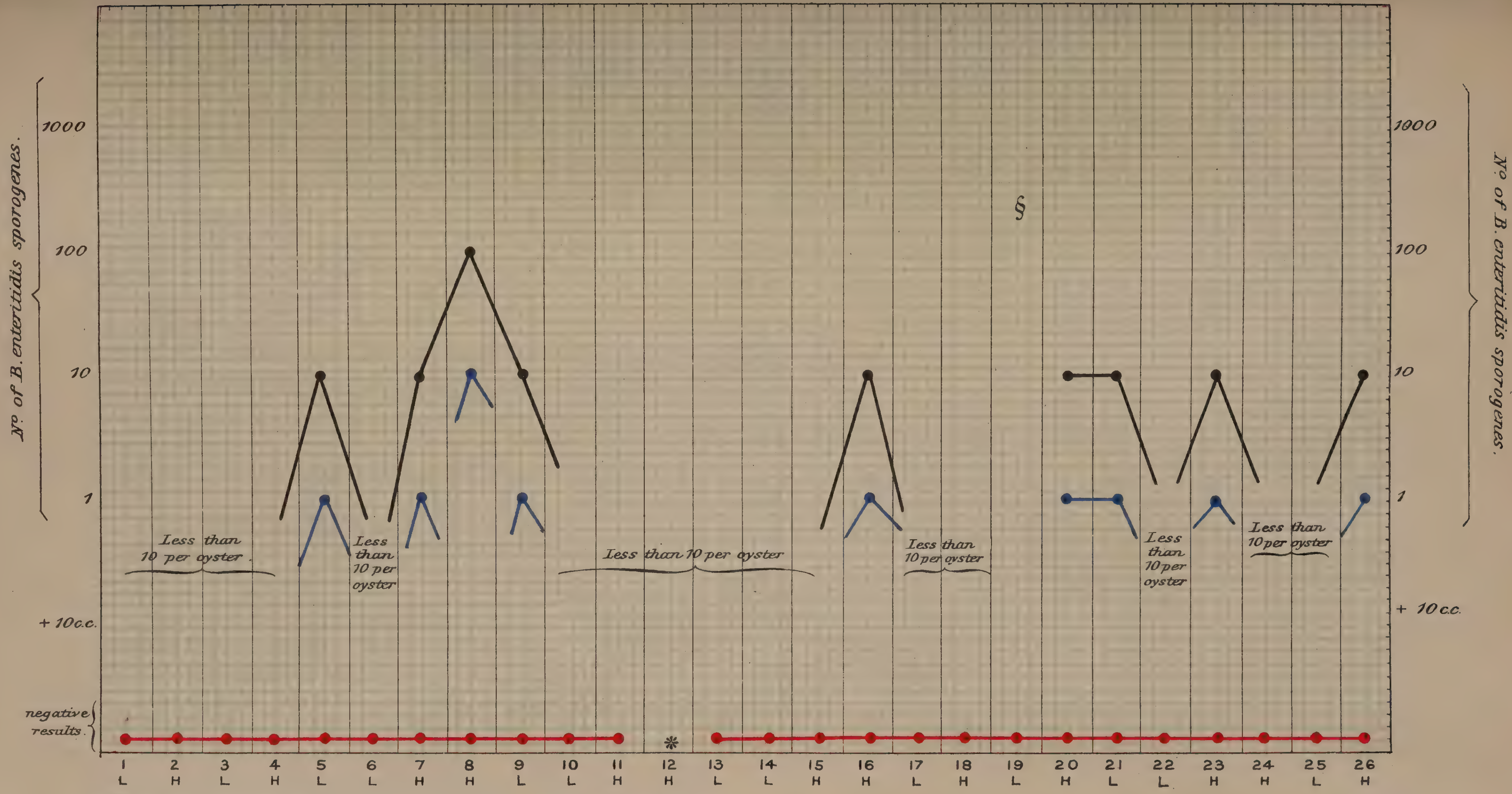

● Nº of B. enteritidis sporogenes per oyster (average of 10 oysters)
● " " " " " " c. c. of oyster the assumption which is nearly correct that each oyster 10 c.c. (average of 10 oysters)
● " " " " " " c. c. of water

* No water examined. § No oysters examined

TABLE 2.

SHOWING the Results of the Bacteriological Examination of the Helford Oysters (*see* Diagrams 1 and 2).

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

TABLE 2, showing the Results of the Bacteriological

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) per oyster (average per 10 oysters).					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.							
1	Low	18	8	1903	Helford River (Tyacke) oysters		+	−			
						Characters of coli from lower*dilution					- -
2	High	18	8	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					- -
3	Low	18	8	,,	Helford River (Tyacke) oysters		+	−			
						Characters of coli from lower dilution					- -
4	High	19	8	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					- -
5	Low	19	8	,,	Helford River (Tyacke) oysters		+	−			
						Characters of coli from lower dilution					- -
6	Low	24	8	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					- -
7	High	24	8	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					- -
8	High	25	8	,,	Helford River (Tyacke) oysters				+	−	
						Characters of coli from lower dilution					- -
9	Low	25	8	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					- -
10	Low	26	8	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					
11	High	26	8	,,	Helford River (Tyacke) oysters				+	−	
						Characters of coli from lower dilution					- -
12	High	31	8	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					- -
13	Low	31	8	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					- -
14	Low	1	9	,,	Helford River (Tyacke) oysters (Porth Navas creek)		+	−			
						Characters of coli from lower dilution					- -
15	High	1	9	,,	Helford River (Tyacke) oysters	+	−				
16	High	7	9	,,	Helford River (Tyacke) oysters			+	−		
						Characters of coli from lower dilution					- -
17	Low	7	9	,,	Helford River (Tyacke) oysters (Porth Navas creek)		+	−			
						Characters of coli from lower dilution					- -
18	High	8	9	,,	Helford River oysters - -			+	−		
						Characters of coli from lower dilution					- -

The number of the samples as regards oysters and waters are in correspondence.

* Throughout the report "lower dilution" signifies the last dilution-but-one yielding coli-like microbes.

Examination of Helford River (Tyacke) Oysters.

3.						4.						5.
Chief Biological Characters of the *strain* of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures) per oyster (average of 10 oysters). Cultures heated to 80° C. for 10 minutes.						Remarks.
Gas. elatine shake" ultures, 4 hours t 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium. + = Acid and gas. 48 hours at 37° C.	Neutral-red broth cultures. + = Greenish-yellow fluorescence. 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(a)	(b)									
+ N.L. + N.L.	– +	+ +	– +	+ +	? – +	- - Less than 10 per oyster - -						10 oysters measured 110 c.c.
+ N.L. + S.L.	– –	+ +	– –	+ –	+ –	- - Less than 10 per oyster - -						10 oysters measured 130 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	– +	- - Less than 10 per oyster - -						10 oysters measured 120 c.c.
+ N.L. + S.L.	– –	+ +	– –	– –	– –	- - Less than 10 per oyster - -						10 oysters measured 130 c.c.
+ N.L. + N.L.	– +	+ +	– +	– +	+ +		+	–				10 oysters measured 120 c.c.
+ N.L. + N.L.	+ –	+ +	+ –	+ –	+ +	- - Less than 10 per oyster - -						10 oysters measured 120 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +		+	–				10 oysters measured 130 c.c.
+ N.L. + N.L.	+ +	+ +	– +	– +	+ ½ +			+	–			10 oysters measured 110 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +		+	–				10 oysters measured 90 c.c.
+ N.L. + N.L.	+ –	+ +	– +	– +	½ + +	- - Less than 10 per oyster - -						10 oysters measured 110 c.c.
+ N.L. + N.L.	– –	+ +	+ +	+ +	+ +	- - Less than 10 per oyster - -						10 oysters measured 100 c.c.
+ N.L. + N.L.	+ (traces) –	+ +	+ +	– +	– +	- - Less than 10 per oyster - -						10 oysters measured 105 c.c.
+ N.L. + N.L.	– –	+ +	– –	+ +	+ +	- - Less than 10 per oyster - -						10 oysters measured 120 c.c.
+ N.L. + N.L.	– +	+ +	+ +	+ +	+ +	- - Less than 10 per oyster - -						10 oysters measured 120 c.c.
+ N.L.	+	+	+	+	+	- - Less than 10 per oyster - -						10 oysters measured 105 c.c.
+ N.L. + N.L.	– +	+ +	+ +	+ +	+ +		+	–				10 oysters measured 120 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +	- - Less than 10 per oyster - -						10 oysters measured 110 c.c.
+ S.L. + N.L.	– –	+ +	– –	+ +	+ +	- - Less than 10 per oyster - -						10 oysters measured 80 c.c.

N.L. (Column 3) signifies no liquefaction, one month. S.L. signifies slow liquefaction.

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

Table 2, showing the Results of the Bacteriologica

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) per oyster (average of 10 oysters).					
No.	Time of Collection.				Other Details.						
	Tide.	Day.	Month.	Year.		1	10	100	1,000	10,000	100,00
19	Low	8	9	1903	Oysters used for special experiment.						
20	High	21	9	,,	Helford River oysters - -	Characters of coli from lower dilution			+	−	-
21	Low	21	9	,,	Helford River oysters - -	Characters of coli from lower dilution		+	−		-
22	Low	22	9	,,	Helford River oysters - -	Characters of coli from lower dilution		+	−		-
23	High	22	9	,,	Helford River oysters - -	Characters of coli from lower dilution		+	−		-
24	High	28	9	,,	Helford River oysters - -	Characters of coli from lower dilution		+	−		-
25	Low	28	9	,,	Helford River oysters - -	Characters of coli from lower dilution		+	−		-
26	Low	29	9	,,	Helford River oysters - -	Characters of coli from lower dilution		+	−		-
						1 out of 25, 4 per cent.	5 out of 25, 20 per cent.	16 out of 25, 64 per cent.	3 out of 25, 12 per cent.		

The number of the samples as regards oysters and waters are in correspondence.

Examination of Helford River (Tyacke) Oysters—*continued.*

3. Chief Biological Characters of the *strain* of B. Coli present in the number specified in Col. 2.						4. B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anaerobic milk cultures) per oyster (average of 10 oysters). Cultures heated to 80° C. for 10 minutes.						5.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.) (a)	(b)	Lactose peptone medium. + = Acid and gas. 48 hours at 37° C.	Neutral red broth cultures. + = Greenish-yellow fluorescence. 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	REMARKS.
+ N.L. + N.L.	- –	+ +	– –	+ +	– +		+	–				10 oysters measured 110 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +		+	–				10 oysters measured 115 c.c.
+ N.L. + N.L.	– –	+ +	+ +	+ +	+ ½ +		Less than 10 per oyster					10 oysters measured 125 c.c.
+ N.L. + N.L.	– +	+ +	– –	– +	– +		+	–				10 oysters measured 110 c.c.
+ N.L. + N.L.	- –	+ +	– +	– +	+ +		Less than 10 per oyster					10 oysters measured 105 c.c.
+ N.L. + N.L.	+ +	– +	– +	– –	+ +		Less than 10 per oyster					10 oysters measured 135 c.c.
+ N.L. + N.L.	– –	+ +	– +	+ +	+ +		+	–				10 oysters measured 120 c c
All positive 100 per cent	23 out of 49 positive, 46·9 per cent.	48 out of 49 positive, 97·9 per cent.	29 out of 49 positive, 59 per cent.	37 out of 49 positive, 75 per cent.	41 out of 49 positive, 83 per cent.	Less than 10 per oyster, 16 out of 25, 64 per cent.	8 out of 25, 32 per cent.	1 out of 25, 4 per cent.				
All positive, 100 per cent.	11 out of 25 positive, 44 per cent.	24 out of 25 positive, 96 per cent.	12 out of 25 positive, 48 per cent.	17 out of 25 positive, 68 per cent.	19 out of 25 positive, 76 per cent.							

N.L. (Column 3) signifies no liquefaction, one month. S.L. signifies slow liquefaction.

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

The method of examination of the oysters is fully described in Addendum A.

Results as regards the presence of B. coli or coli-like microbes in the Helford oysters :—

The results are shewn in Table 2 and Diagram 1.

In the table the results are stated as number per oyster (*i.e.*, the whole contents of the oyster shell), but as in each case the entire contents of the shell are stated in cubic centimetres, it is possible also to give them as number per c.c. of oyster. For practical purposes as regards small to medium-sized oysters (*e.g.*, Helford oysters), it is sufficiently near the mark to regard the entire contents of the shell (body and liquor) as approximately equivalent to 10 c.c. In this view of the case, in order to obtain a direct comparison between the number per c.c. of water and oyster respectively, it is only necessary to divide the figures as regards oysters by 10. Primarily the results will be considered as number of B. coli or coli-like microbes per oyster (average of 10 oysters in each case).

1 out of 25 (4%) contained 1 B. coli or coli-like microbe per oyster.*
5 out of 25 (20%) contained 10 B. coli or coli-like microbes per oyster.
16 out of 25 (64%) contained 100 B. coli or coli-like microbes per oyster.
3 out of 25 (12%) contained 1,000 B. coli or coli-like microbes per oyster.

The percentage number of coli-like microbes yielding a positive response to each of the individual tests for B. coli is shewn in the table. As previously indicated, the degree of positive response to the various tests is not nearly so well marked as regards the oysters as was the case in the water over the oysters. On the other hand, the numerical figures are far higher in respect of the oysters. Treating the extreme results in a somewhat arbitrary fashion, and ignoring for the purposes of a broad comparison the occasional presence of B. coli in 1 c.c. of the water, it would appear that the oysters are apt to contain about 100 times more B. coli or coli-like microbes than the water.

Results as regards the presence of B. enteritidis sporogenes in the Helford oysters. (Table 2 and Diagram 2.)

The results may be briefly summarised as follows :—

Less than 10 spores of B. enteritidis sporogenes per oyster, 16 out of 25, 64 per cent.

8 out of 25 contained 10 but less than 100, 32 per cent.

1 out of 25 contained 100 but less than 1,000, 4 per cent.

The following is a brief summary of the results of the bacteriological examination of the water and oysters :—

Description of Sample.	Number of B. Coli, or coli-like microbes, per c.c. of water, per oyster and per c.c. of oyster.						Number of spores of B. enteritidis sporogenes per c.c. of water, per oyster and per c.c. of oyster.		
	+in 100 c.c.	+in 10 c.c.	1	10	100	1,000	Less than 10	10	100
Helford water, 25 samples.	+ 28 per cent.	+ 40 per cent.	+ 32 per cent.	–	–	–	Negative result, 10 c.c. of water 100 per cent.		
Helford Oysters, 25 batches of 10. Results stated as number per oyster.			+ 4 per cent.	+ 20 per cent.	+ 64 per cent.	+ 12 per cent.	Less than 10 64 per cent.	+ 32 per cent.	4 per cent.
Helford Oysters, 25 batches of 10. Results stated as number per c.c. of oyster.		+ 4 per cent.	+ 20 per cent.	+ 64 per cent.	+ 12 per cent.		Less than 10 96 per cent. but at least 1 per c.c. of oyster, 32 per cent.	+ 4 per cent.	

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* To obtain approximate results per c.c. of oyster divide the above figures by 10.

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

The remarkable distinction between the water over the oysters and the oysters themselves, both as regards the B. coli and the B. enteritidis sporogenes tests, is apparent from the above table and the accompanying diagrams. At the same time it must be remembered that the coli-like microbes derived from the water, although much fewer in number, were more often typical than in the case of the oysters.

If, for the purposes of a broad comparison, it is permissible to ignore the worst results as regards both the water and oysters, then it may be said that the water contained B. coli or coli-like microbes either in 100 c.c. or 10 c.c., but most often in the latter amount. That the oysters contained 10 to 100 B. coli or coli-like microbes per oyster, or 1 to 10 per c.c. of oyster, but most often the major figure. Hence, according to the above calculation, the oysters were about 100 times more impure per c.c. of oyster, than the water.

As regards the B. enteritidis sporogenes test, it may be said that while none of the samples of water yielded a positive result with 10 c.c., one-third of the samples of oysters contained 10 spores per oyster, or 1 spore per c.c. of oyster.

Division IV. Bacteriological Examination of the Helford and Penryn Water and Oysters.

PART II.

PENRYN RIVER (CORNWALL).*

The Penryn River is situated on the Cornish coast in the neighbourhood of Falmouth. For the purposes of this inquiry it may be considered to extend from Penryn, a town of some 3,190 inhabitants, to Falmouth, on the left side (11,773 inhabitants), and Flushing, on the right side (800 inhabitants), and somewhat beyond these towns, in a south-easterly direction, to merge into the waters of the Carrick Roads.

The Carrick Roads is an immense waterway extending from an arbitrary line connecting St. Anthony's Head and Pendennis Point up to the commencement of the Fal River.

Seawards of the former arbitrary line, Carrick Roads opens out into Falmouth Bay and the English Channel.

Pursuing the coast line westwards for a few miles, the opening of the Helford River is found between Rosemullion and Nare Points.

The term river is to some extent misleading, for that portion of the Penryn River concerned in this report resembles a fan-shaped creek, the quality of the water being dominated by the ingress of a vast volume of sea water.

It may be true that the wider the "angle of aperture," if such a term is permissible, in connection with estuarial waters, the greater is the difficulty likely to be of arriving at other than tentative conclusions *qua* dangerous pollution.

The proportion of fresh water in the case of Penryn River, within the confines of my investigation, must, I think, be regarded as relatively insignificant.

In this, as well as in other directions, it may be surmised that chemical investigations might yield results of value. Indeed, so enormous is the amount of chlorine in sea water, as compared with fresh water and even sewage, that the presence of comparatively small amounts of these latter liquids in sea water would appreciably alter the chlorine figures. It is probable that too little is known of the chemical qualities of estuarial waters in relation to pollution.†

As regards the oyster layings in the Penryn River, and the liability of these layings to sewage pollution, it is of advantage to quote somewhat fully from Dr. Bulstrode's report.

> "The oyster layings in this river extend from just westward of an imaginary line drawn from Flushing New Quay to the Greenbank Quay," . . . . . . "to within about one-fourth of a mile of Penryn Quay. There are at places certain areas where no oysters are laid down, but the layings may be generally taken as extending up both sides of the river between the points indicated. On the fore-shore of the river at Flushing are numerous layings belonging to fishermen and others, each man despatching his own stock to market, or getting rid of them to larger buyers. There are, too, hereabouts, on the northern side of the river, certain layings which are used for wintering the foreign stock of a London firm, and also for the growth and fattening of French oysters. These oysters are sent down from more eastern waters in October and November, and returned in March or April. As a rule attempts are made to sell the French oysters direct from these northern waters before the cold weather sets in; when that has occurred the trade is carried on from the Flushing beds. On the Falmouth side of the Penryn River the layings are less numerous, but each is of greater extent; indeed, from near the Greenbank Hotel to near Boyer's Cellars the ground is held by two large merchants. One of them does a large trade in oysters dredged up from the Carrick Roads; while the other lays down much French produce. All oysters from the Penryn River are, as a rule, sent direct to market."

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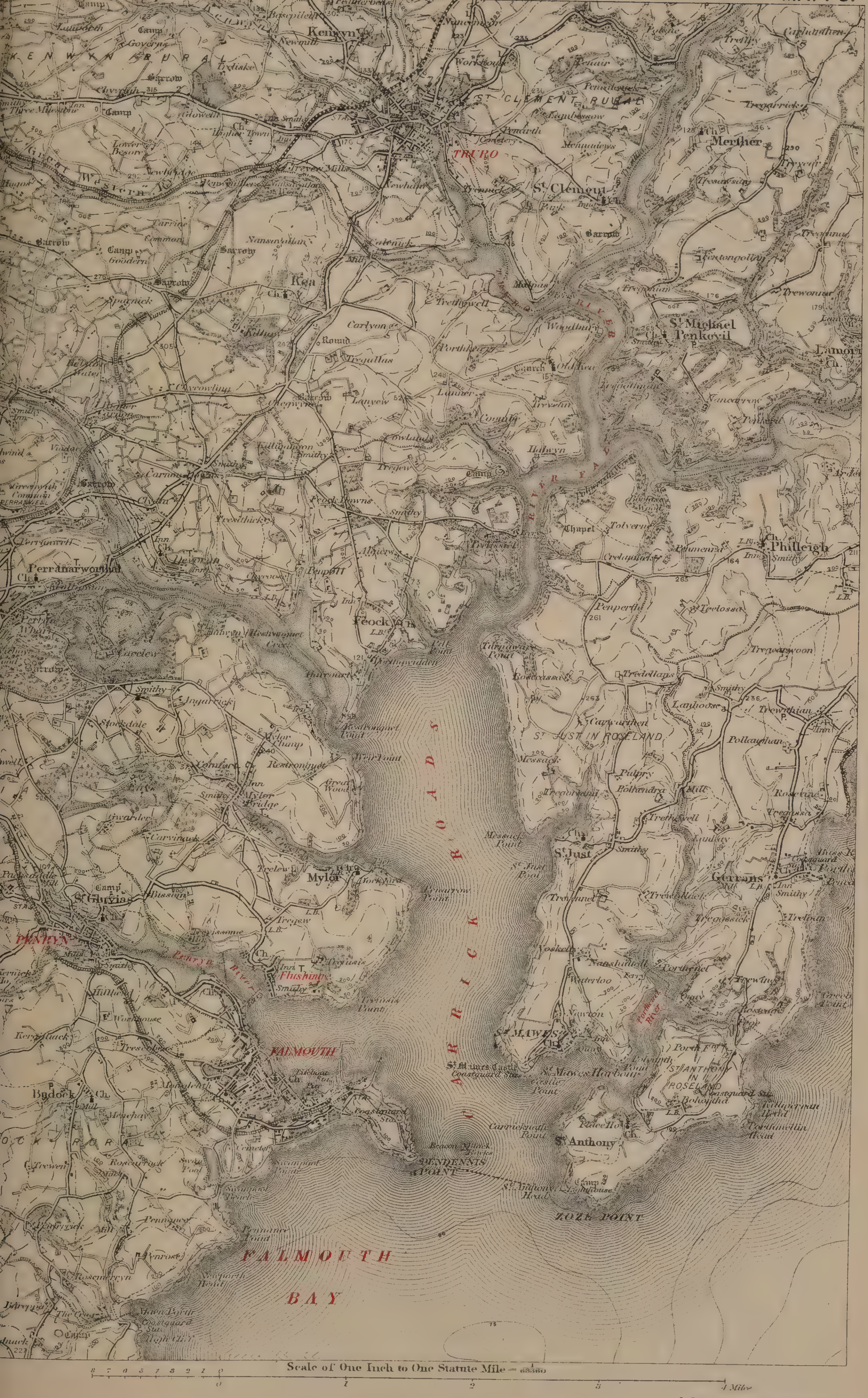
* A general idea of the locality will be formed best by looking at Map 2 (4 miles to 1 inch). Map 3 (1 mile to 1 inch) shows in more detail Penryn and its surroundings.

† Upland waters contain about 1, sewage about 10, and sea water from 1,500 to 1,800 parts per 100,000 of chlorine. The researches of Adeney, Letts, and many other chemists, clearly show the value of the chemical testing of estuarial waters.

PENRYN RIVER AND ITS SURROUNDINGS



Scale of One Inch to One Statute Mile = $\frac{1}{63360}$

Ordnance Survey, Southampton.

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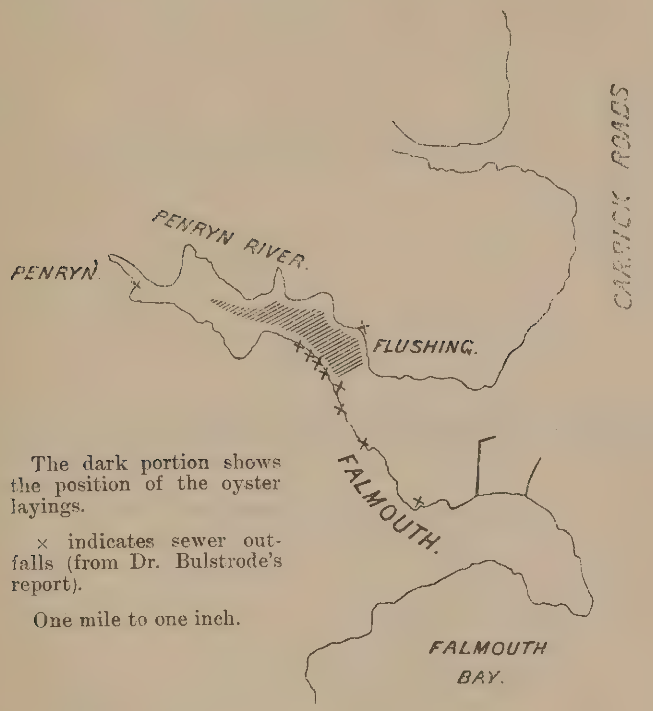
Bacteriological Examination of the Helford and Penryn Water and Oysters.

Dr. Bulstrode thus describes, *"Sewage disposal in relation to the above several Oyster Layings"* :—

"The Sewage of Falmouth (population 11,632), is partly treated and partly untreated, the greater portion being treated. The treatment consists of the addition of precipitants, (sulphate of alumina and lime), storage in tanks, and a rough filtration through vertical screens, the interval between which is filled with coarse stone. Of the "treated sewage," the effluent is discharged into the inner harbour at Market Strand and near the Bar, while the sludge is carried out in barges to sea. The "untreated" sewage finds its way into the inner harbour, mainly by two outfalls; one near the Custom House, where the sewage of some 25 houses empties itself, the other about 100 yards eastward of the Greenbank Quay, where the sewage of Penwerris, some 116 houses, discharges. In addition, 170 houses, or thereabouts, which are too low to be drained into the common sewer, discharge independently upon the foreshore at different points. Eastward of the Greenbank Quay are sundry drains or sewers, from a few houses near, discharging themselves on the foreshore."

"At Penryn ...., the main sewer of Penryn, population 3,256, discharges itself, and at other places along the quay other small sewers discharge."



The dark portion shows the position of the oyster layings.

× indicates sewer outfalls (from Dr. Bulstrode's report).

One mile to one inch.

"The liability of the Oyster Layings to sewage pollution," is thus described by Dr. Bulstrode :—

"As to the oyster layings in the Penryn river, it is to be regretted that a similar statement cannot be made. It will be seen .. .. that the layings extend to within a quarter of a mile of Penryn Quay, where the crude sewage of the town of Penryn is discharged. At low tide the river hereabouts is a mere rivulet, and not navigable by the smallest rowing boats; indeed, a considerable part of the water passing down the bed of the stream when the tide is out must be composed of Penryn sewage, and this, as it finds its way seaward, cannot fail to pass over some of the oyster layings.

"At Flushing there are, as has been already stated, sundry slop-water drains and sewers discharging on to the foreshore. In some instances oysters are laid down within about six yards of the quay wall, and within some 30 yards of the main outfall and extensive oyster layings. Obviously all the layings hereabouts are not exposed in the same degree to risks of contamination, those farthest removed from the quay being much less liable to pollution.

"On the opposite side of the river near to the layings thereabouts, between Boyer's Cellars and the Greenbank Quay, are several small drain outlets, and at the quay itself, another. About 100 yards seaward of the Greenbank Quay is the Penwerris outfall already referred to.

"Having regard to all these facts, Penryn river cannot be viewed in the light of a safe locality for preparing oysters for market; in fact, oysters near to Penryn must be regarded as occupying a dangerous position. The whole length of the Penryn River from the Penryn Quay to the Greenbank Quay does not exceed 1½ miles."

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

Preliminary Work:—

During April 1903. A visit was paid to Cornwall, and a number of samples collected. Later, Dr. Edmonston Charles was kind enough to collect and transmit to me further samples. In August, a second visit was paid to Cornwall.

The results are set forth in the following tables, and the sites of collection marked on Map 4.

It will be convenient in the first place to consider the results of the Bacteriological Examination of samples of Penryn River Water.

TABLE 3

Showing the Results of the Bacteriological Examination of Penryn River Water (*see* Map 4).

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

TABLE 3, showing the Results of the Bacteriologica

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. coli (or gas-forming coli-like microbes) in 1 c.c.						
No.	Time of Collection.				Other Details.	+ 10 c.c.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
37	$\frac{5}{8}$ ebb	24	4	1903	Penryn River, boat sample, Flushing side of mid channel and 200 yards west of ferry.	+	−					
38	$\frac{1}{8}$ flood	24	4	,,	Penryn River, boat sample, mid-stream, opposite Boyer's Cellars.			+	−			
39	$\frac{1}{3}$ flood	24	4	,,	Penryn River, near Penryn, boat sample, mid-stream, opposite granite yard.			+	−			
40	$\frac{1}{8}$ flood	24	4	,,	Penryn River, at Penryn quay, boat sample, mid-stream, shallow water.						+	[illegible]
45	Low tide. Evening.	24	4	,,	Penryn River, boat sample, mid-way between Greenbank and Flushing quays.		+	−				
40	High tide	26	4	,,	Penryn River, boat sample, mid-way between Greenbank and Flushing quays.		+	−				
1	1 hour ebb	13	5	,,	Penryn River, boat sample, mid-way between Greenbank and Flushing quays.		+	−				
2	3 hours ebb	13	5	,,	Penryn River, boat sample, off granite works.						+	−
3	$4\frac{1}{2}$ hours flood	13	5	,,	Penryn River, boat sample, mid-way between Greenbank and Flushing quays.	+	−					
4	3 hours flood	13	5	,,	Penryn River, boat sample, off granite works.				+	−		
6	$\frac{5}{6}$ flood	19	5	,,	Penryn River, boat sample, mid-way between Greenbank and Flushing quays.	−						
9	High water	20	5	,,	Penryn River, boat sample, off granite works.				+	−		
10	$\frac{2}{3}$ ebb	20	5	,,	Penryn River, boat sample, off granite works.				+	−		
11	$\frac{5}{6}$ ebb	20	5	,,	Penryn River, boat sample, mid-way between Greenbank and Flushing quays.	+	−					
5A	Average sample	17	8	,,	Penryn River, boat sample, mid-way between Greenbank and Flushing quays. Average sample.	+	−					
11A	Average sample	18	8	,,	Penryn River, boat sample, mid-way between Boyer's Cellars and Sailors' Creek. Average sample.		+	−				
15A	Average sample	19	8	,,	Penryn River, boat sample, mid-way between Greenbank and Flushing quays. Average sample.	+	−					
17A	Average sample	20	8	,,	Penryn River, boat sample, mid-way between Greenbank Church and Seven Stars Inn at Flushing. Average sample.			+	−			

Examination of Samples of Water from the Penryn River.

3				4						5
Chief Biological Characters of the *strain* of B. coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes Test. Spores of B. enteritidis sporogenes. (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+	+	+	+	−	(Positive 10 c.c.)					Collected during first visit to Cornwall.
+	+	+	+	−	ditto					
+	+	+	+	+	−					
+	+	+	+		+	−				
+	+	+	+	−	(Positive 10 c.c.)					
+	−	+	+	+	−					
+	+	+	+	−	(? Negative 10 c.c.)					Collected through the kindness of Dr. Charles.
+	+	+	+		+	−				
+	+	+	+	−	(Negative 10 c.c.)					
+	+	+	+		+	−				
				−	(Positive 10 c.c.)					
+	+	+	+		+	−				
+	+	+	+		+	−				
+	+	+	+	−	(? Positive 10 c.c.)					
+	+	+	+*	−	(Negative 10 c.c.)					Collected during second visit to Cornwall. All the samples were *average* samples, equal quantities of the water being collected every hour for six hours and then mixed together. * All these *strains* of B. coli yielded positive results with the lactose peptone and neutral-red broth tests.
+	+	+	+*	−	(Positive 10 c.c.)					
+	+	+	+*	−	ditto					
+	+	+	+*	−	(Negative 10 c.c.)					

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

Penryn River:—

These results show that the Penryn River in its upper reaches is grossly polluted. The number of B. coli varied from 100 to 10,000 per c.c. The B. enteritidis sporogenes test usually gave a positive result with $\frac{1}{10}$ c.c. So far agreement with Dr. Bulstrode's conclusions is complete. But within a mile of the place where these observations were taken, the change *qua* bacteriological results is most abrupt. While in entire accord with Dr. Bulstrode's views as to the gravity of localised areas of pollution, it must be added that, in the writer's opinion, the general body of water in the region of Falmouth and Flushing, by no means abounds in microbes of intestinal origin. The uninstructed or casual reader might possibly, from Dr. Bulstrode's report, draw the erroneous conclusion that the *general body of water* in the inner Falmouth Harbour is polluted to a gross extent. Judging from the bacteriological facts, this is not the case. Indeed, the water in this region was often found to be bacteriologically from *ten thousand to one hundred thousand times purer than sewage.* That the degree of sewage contamination is great in *localised areas* is doubtless true, but the bacteriological facts suggest that the *degree* of pollution of the water *generally* is by no means great. These remarks have an important bearing on the comparison between the bacteriological examination of the water and oysters in the Helford and Penryn Rivers respectively. It must not be assumed in instituting comparisons that at Helford River the water was biologically absolutely above suspicion, still less that at Penryn the water was swarming with microbes of intestinal origin.

The facts, as they stand, are that the Helford River is only relatively pure biologically,* and that the Penryn River in its *lower reaches* is quite appreciably, but still not *grossly*, polluted.

It might, in practice, be difficult to find a purer spot than the Helford River, but this circumstance must not lead to the converse and erroneous supposition, namely, that it would be impossible to find a more polluted river in the general sense above indicated, than the Penryn River.

These considerations ought to be borne in mind in relation to the comparative records as regards water and shell-fish obtained at Helford and Penryn.

Without pressing the point unduly it may be said that as regards Penryn the bacteriological results modified the unfavourable provisional opinions formed as the outcome of topographical observations.

Character of the sea water *outside the Penryn River and in the adjoining creeks and rivers:—*

Before proceeding to give an account of the routine examinations of the Penryn oysters and surrounding water, it is convenient to consider the results of the bacteriological examination of samples of water from the Carrick Roads, Fal River, Truro River, Porthcuel River, Falmouth Bay and St. Mawes' Creek (Table 4).

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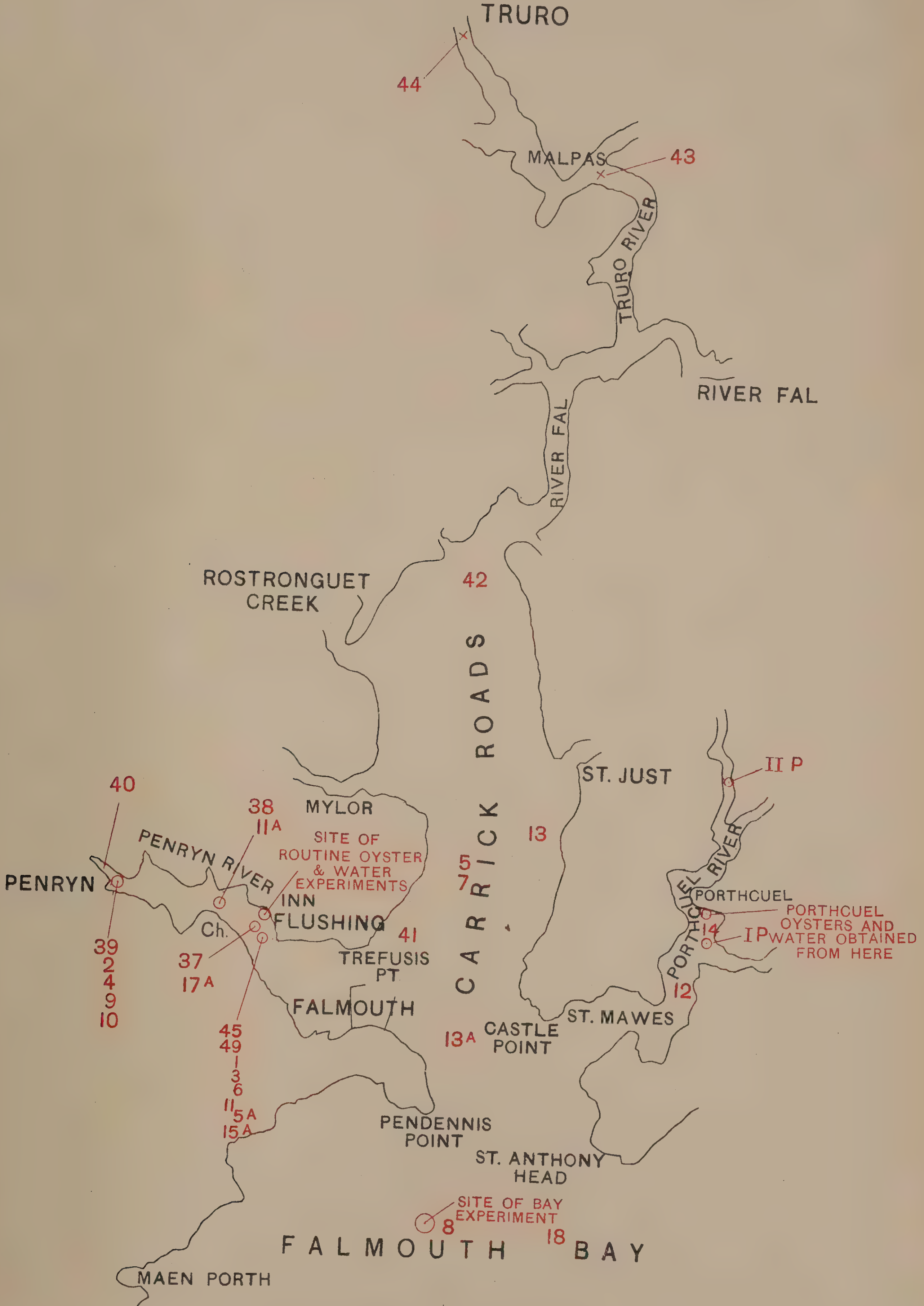
* At the same time, the origin of the observed slight *biological* impurity of the Helford River is matter for conjecture. It may indeed be, and probably is the case, that in all estuarial waters we must allow for a slight degree of biological impurity as practically unavoidable and possibly inexplicable, and that only waters should be objected to which exceed to an appreciable extent what might be termed the *permissible limit of biological impurity.* But where the line should be drawn has yet to be determined.

Map 4.

Sketch Map of the River Penryn & its Surroundings.



SCALE OF ONE MILE TO ONE INCH.

Printed at the Ordnance Survey Office, Southampton, 1903.

TABLE 4.

SHOWING the Results of the Bacteriological Examination of samples of water from the Carrick Roads, Fal River, Truro River, Porthcuel River, Falmouth Bay, and St. Mawes Creek (*see* Map 4).

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

TABLE 4, showing the Results of the Bacteriological Examination of Samples of Water from the

1.						2.						
DESCRIPTION OF THE SAMPLE.						Number of B. coli (or gas-forming coli-like microbes) in 1 c.c.						
No.	Time of Collection.				Other Details.	+ 10 c.c.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
41	About high tide.	24	4	1903	Carrick Roads, north of Trefusis Point, steamer sample.	−						
42	About high tide.	24	4	,,	Mouth of Fal River, steamer sample.	−						
43	⅙ ebb tide.	24	4	,,	Truro River at Malpas, steamer sample.	−						
44	⅓ ebb tide.	24	4	,,	Truro River, about ½ mile below Truro, steamer sample.				+	−		
5	3½ hours ebb.	14	5	,,	Carrick Roads, north of Trefusis Point, off the Velt Buoy, near mid channel.	+	−					
7	¼ hour before high water.	19	5	,,	Carrick Roads, north of Trefusis Point, off the Velt Buoy.	−						
13	2 hours ebb.	2	6	,,	Carrick Roads, off St. Just's Buoy, wind N.E.	−						
8	17 mins. after high tide.	19	5	,,	Falmouth Boy, a short mile off Black Rock.	−						
12	1 hour ebb.	1	6	,,	St. Mawes' Creek, between Place and Porthcuel.	−						
14	¾ flood.	19	8	,,	Porthcuel River, off Porthcuel.			(Negative 100 c.c.)				
13A	½ flood.	19	8	,,	Carrick Roads, South of and close to Governor Buoy.			(Negative 100 c.c.)				
18	½ flood.	21	8	,,	Carrick Roads, one mile seawards of Black Rock buoy.	−	(Positive, however, 100 c.c.)					

Carrick Roads, Fal River, Truro River, Porthcuel River, Falmouth Bay, and St. Mawes' Creek.

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

3.				4.						5
Chief Biological Characters of the strain of B. coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes Test. Spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hrs. at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
				–		(Negative 10 c.c.)				Collected during first visit to Cornwall.
				–		(Negative 10 c.c.)				
				–		(Negative 10 c.c.)				
+	+	+	+	+	–					
+	+	+	+	–		(Negative 10 c.c.)				Collected through the kindness of Dr. Charles during May and June.
				–		(? Negative 10 c.c.)				
				–		(Negative 10 c.c.)				
				–		(Negative 10 c.c.)				
				–		(Negative 10 c.c.)				
				–		(Negative 10 c.c.)				Collected during second visit to Cornwall.
				–		(Negative 10 c.c.)				
				–		(Negative 10 c.c.)				
+	–	+	+							
[Negative lactose peptone test; ½ positive neutral-red broth test; slowly liquified gelatine.]										

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

The foregoing table shows that the water in Carrick Roads, Fal River, *lower* reaches of the Truro and Porthcuel Rivers, and Falmouth Bay was of a high degree of biological purity. It would occupy too much space to quote from Dr. Bulstrode's report in this connection, but his conclusions are fully supported by the bacteriological facts.

None of these samples, except one, contained B. coli, even in 10 c.c., and none of them (query one) B. enteritidis sporogenes in a like amount of water.

It is of considerable interest to contrast these satisfactory results with sample 44, which was collected about half-a-mile below Truro. This sample contained B. coli in $\frac{1}{100}$ c.c., and B. enteritidis sporogenes in 1 c.c. In this connection, Dr. Bulstrode's report may be quoted, as follows :—

> "The sewage of Truro (population 11,151) is, I am informed by the Borough Surveyor, discharged by numerous outfalls into one or other of the tributaries, Allen and Kenwyn, which uniting below the city, form the Truro River. At low tide the condition of both these streams, more especially in certain localities, is offensive to the senses of sight and smell. The Truro River itself, from the city down to the village of Malpas, is, at low tide, but a small and tortuous rivulet, not even navigable by an ordinary rowing boat; so that, especially in the more rainless months, a considerable portion of the stream must consist of the sewage and slop-water of Truro."

Speaking in general terms it may be said that the waters described in the foregoing table were about 10,000 times purer than sample 44 collected in the neighbourhood of Truro.

As regards the Porthcuel River a number of samples of oysters and water were obtained subsequently from this locality. The results are dealt with in Addendum C.

Results of the Routine Bacteriological Examination of the Penryn water and oysters.

The enquiry was commenced in August 1903. It will be convenient to consider in the first place the :—

Results of the Bacteriological Examination of the water over the oysters.

The results are set forth in detail in the following table (Table 5) :—

TABLE 5.

Showing the Results of the Bacteriological Examination of the Penryn River Water over the Oyster Layings (*see* Map 4 and Diagrams 3 and 4).

Bacteriological Examination of the Helford and Penryn Water and Oysters.

TABLE 5, Showing the Results of the Bacteriological

1.						2.							
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.							
No.	Time of Collection.				Other Details.	+ 100 c.c.	+ 10 c.c.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
1	Low	14	8	1903	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	−				
2	High	17	8	,,	Penryn River water over oyster layings.		+	−					
3	High	18	8	,,	Penryn River water over oyster layings.		+	−					
4	Low	20	8	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	−			
5	Low	24	8	,,	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	−				
6	Low	26	8	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	−			
7	High	28	8	,,	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	−				
8	Low	1	9	,,	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	−				
9	High	4	9	,,	Penryn River water over oyster layings.			Characters of the coli from 0·1 c.c, culture		+	−		
10	Low	7	9	,,	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	−				
11	High	11	9	,,	Penryn River water over oyster layings.		+	−					
12	High	15	9	,,	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	−				
13	Low	16	9	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	−			
14	Low	18	9	,,	Penryn River water over oyster layings.		+	−					
15	High	18	9	,,	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	−				
16	Low	22	9	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	−			
17	High	22	9	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	−			
18	High	23	9	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	−			
19	Low	23	9	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	−			

Examination of the Penryn River Water over the Oyster Layings.

3.						4.						5.
Chief Biological Characters of the *strain* of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of Spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anaerobic milk cultures). Cultures heated to 80° C. for 10 minutes.						**Remarks.**
Gas. (Gelatine "shake" cultures, 24 hours, at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.	(*a*) Acidity. (*b*) Clot). (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium. + = acid and gas, 48 hours at 37° C).	Neutral-red broth cultures, + = greenish-yellow fluorescence, 48 hours at 37° C.	1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 .0001 c.c.	100,000 ·00001 c.c.	
		(*a*)	(*b*)									
+ N.L.	+	+	+	+	+	—		(Positive 10 c.c.)				
+ N.L.	–	+	+	+	+							
+ N.L.	–	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+	—		(Positive 10 c.c.)				
+ S.L.	–	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	–	–	–	–	–	—		(Positive 10 c.c.)				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	–	+	—	–	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	–	+	–	–	+	—		(Positive 10 c.c.)				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+	—		(Positive 10 c.c.)				
+ S.L.	–	+	+	–	–							
+ N.L.	–	+	–	+	+			Negative 10 c.c.				
+ N.L.	+	+	–	+	+	—		(Positive 10 c.c.)				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	–	+	+			Negative 10 c.c.				
+ N.L.	—	+	+	–	+							
+ N.L-	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	—	+	—	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+	—		(Positive 10 c.c.)				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+	—		(Positive 10 c.c.)				
+ N.L.	+	+	+	+	+							
+ N.L.	–	+	–	–	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	–	+	+	+	+	—		(Positive 10 c.c.)				
+ N.L.	+	+	+	+	+							

N.L. signifies that no liquefaction of gelatine occurred (one month).

S.L. signifies that slow liquefaction of gelatine occurred (one month).

TABLE 5.—Showing the Results of the Bacteriological

1.						2.							
DESCRIPTION OF THE SAMPLE.						No. of B. Coli (or gas-forming coli-like microbes) in 1 c.c.							
No.	Time of Collection.				Other Details.	+ 100 c.c.	+ 10 c.c.	1	10	100	1,000	10,000	100,000
	Time.	Day.	Month.	Year.				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
20	High	25	9	1903	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	–			
21	Low	25	9	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	–			
22	High	29	9	,,	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	–				
23	Low	28	9	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c.c. culture	+	–			
24	High	30	9	,,	Penryn River water over oyster layings.			Characters of the coli from 1 c,c. culture	+	–			
25	Low	30	9	,,	Penryn River water over oyster layings.			+ Characters of the coli from 10 c.c. culture	–				
The numbers of the sample, as regards waters and oysters, are in correspondence.							4 out of 25, 16 per cent.	9 out of 25, 36 per cent.	11 out of 25, 44 per cent.	1 out of 25, 4 per cent.			

Examination of the Penryn River Water—*continued.*

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

3.						4.						5.
Chief Biological characters of the *strain* of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of Spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hrs. at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose Peptone medium, + = acid and gas, 48 hours at 37° C.	Neutral-red broth cultures, + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(a)	(b)			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+ N.L.	+	+	+	+	+	–	(Positive 10 c.c.)					
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+	–	(Positive 10 c.c.)					
+ N.L.	+	+	+	+	+							
+ N.L.		+	–	–	+	–	(Positive 10 c.c.)					
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+	–	(Positive 10 c.c.)					
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+	–	(Positive 10 c.c.)					
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+		Negative 10 c.c.					
+ N.L.	–	+	+	+	+							
All positive, 100 per cent.	32 out of 46 positive, 69·5 per cent.	45 out of 46 positive, 97·8 per cent.	37 out of 46 positive, 80 per cent.	39 out of 46 positive, 84·7 per cent.	43 out of 46 positive, 93·4 positive.	All negative (= 100 per cent.)	14 out of 25 positive, with 10 c.c. (56 per cent.), but negative with 1 c.c.					
All positive, 100 per cent.	16 out of 25, positive, 64 per cent.	24 out of 25 positive, 96 per cent.	16 out of 25 positive, 64 per cent.	20 out of 25 positive, 80 per cent.	23 out of 25 positive, 92 per cent.		11 out of 25 negative, with 10 c.c. (44 per cent.).					

N.L. signifies that no liquefaction of gelatine occurred (one month).

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

Results as regards the presence of B. coli or coli-like microbes in the Penryn water over the oysters.

The results shewn in Table 5 and Diagram 3, may be summarised as follows :—

4 out of 25 samples (16%) contained B. coli or coli-like microbes in 10 c.c., but not in 1 c.c.
9 out of 25 samples (36%) contained B. coli or coli-like microbes in 1 c.c., but not in 0·1 c.c.
11 out of 25 samples (44%) contained B. coli or coli-like microbes in 0·1 c.c., but not in 0·01 c.c.
1 out of 25 samples (4%) contained B. coli or coli-like microbes in 0·01 c.c., but not in 0·001 c.c.

As regards the biological attributes of the coli-like microbes, the percentage number yielding positive response to each individual test and to the tests collectively, was great, but not so great as in the case of the Helford River. But, of course, the numerical results were highest in the Penryn water.

Results as regards the presence of B. enteritidis sporogenes in the water over the oysters. (Table 5 and Diagram 4.)

The Helford samples of water, it will be remembered, all gave a negative result with 10 c.c. The Penryn samples yielded results as follows :—

14 out of 25 positive with 10 c.c. (56%), but negative with 1 c.c.
11 out of 25 negative with 10 c.c.

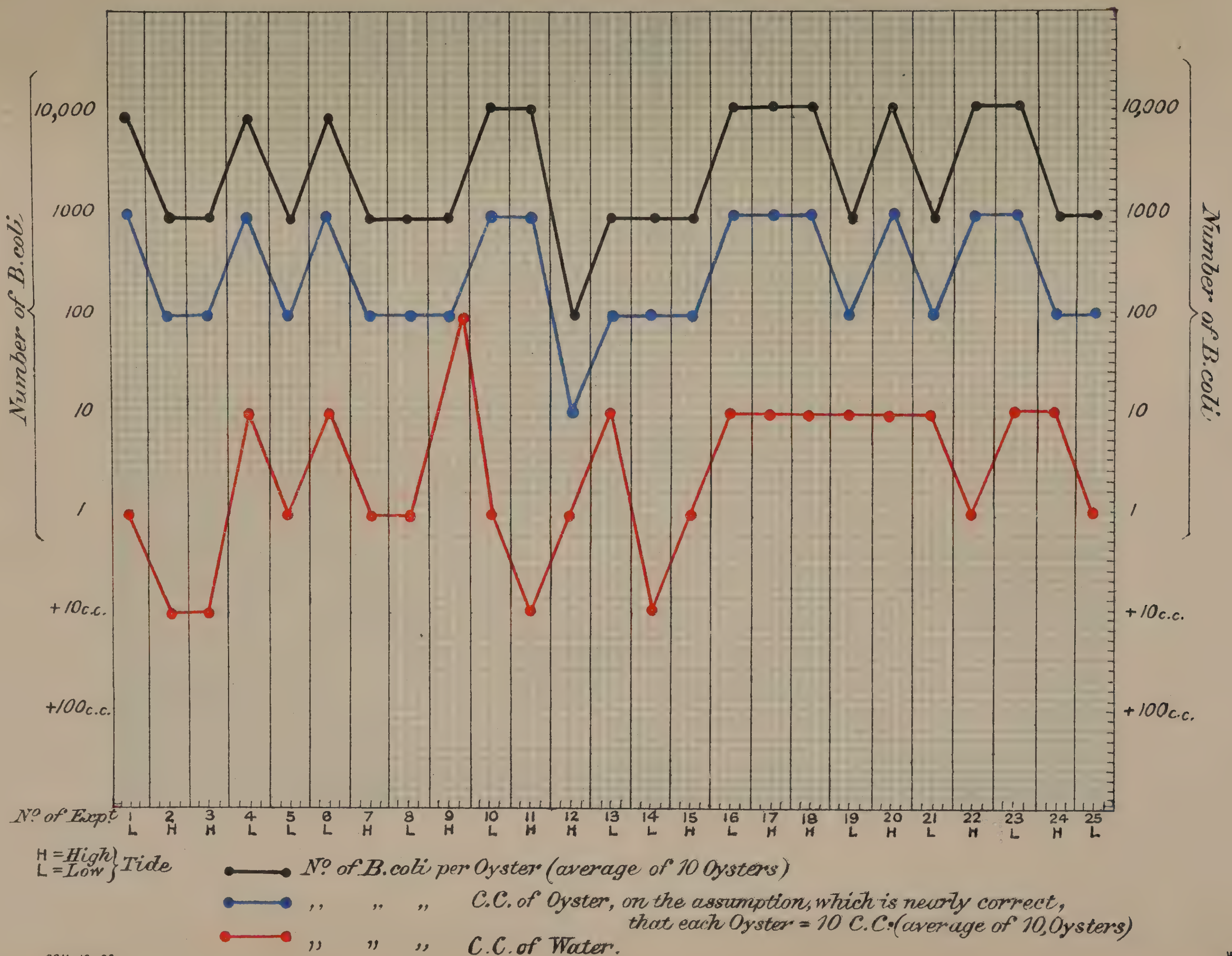
The following is a brief summary of the chief bacteriological results given in detail in Table 5 :—

B. coli or coli-like microbes.				B. enteritidis sporogenes.
10 c.c.	1 c.c.	·1 c.c.	·01 c.c.	10 c.c.
Positive result	Positive result	Positive result	Positive result	Positive result
16 per cent.	36 per cent.	44 per cent.	4 per cent.	56 per cent.
				Negative result
				44 per cent.

Neglecting extremes, it may be said that the water usually contained from 1 to 10 B. coli or coli-like microbes per c.c., and that about half the samples contained B. enteritidis sporogenes in 10 c.c.

The results of the bacteriological examination of the Penryn oysters may next be considered.

Diagram 3. showing, as regards B. coli, the results of the Bacteriological Examination of samples of Water & Oysters obtained from the Penryn River.



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Examination of samples of water & oysters obtained from the Penryn River.

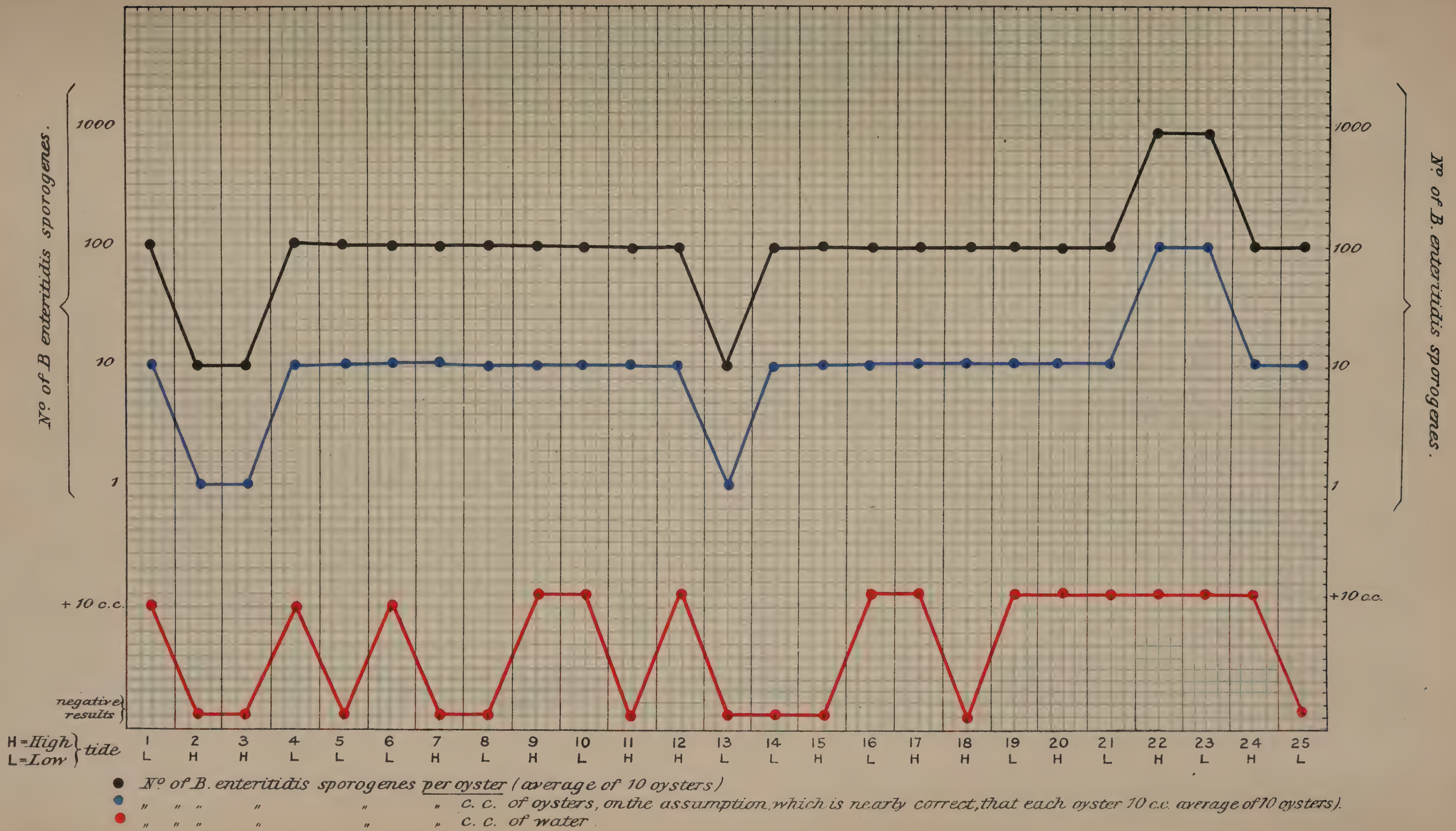

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TABLE 6.

SHOWING the Results of the Bacteriological Examination of the Penryn Oysters (*see* Map 4 and Diagrams 3 and 4).

TABLE 6.—Showing the Results of the Bacteriological

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) per Oyster (average of 10 Oysters).					
No.	Time of Collection.				Other Details.						
	Tide.	Day.	Month.	Year.		1	10	100	1,000	10,000	100,000
1	Low	14	8	1903	Penryn River oysters - - -	Characters of coli from lower dilution- -				+	–
2	High	17	8	,,	Penryn River oysters - - -	Characters of coli from lower dilution-			+	–	
3	High	18	8	,,	Penryn River oysters - - -				+	–	
4	Low	20	8	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -				+	–
5	Low	25	8	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -			+	–	
6	Low	26	8	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -				+	
7	High	28	8	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -			+	–	
8	Low	1	9	,,	Penryn River oysters - - -				+	–	
9	High	4	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -			+	–	
10	Low	7	9	,,	Penryn River oysters - . -	Characters of coli from lower dilution- -				+	–
11	High	11	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -				+	–
12	High	15	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -		+	–		
13	Low	16	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -			+	–	
14	Low	18	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -			+	–	
15	High	18	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -			+	–	
16	Low	22	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -				+	–
17	High	22	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -				+	–
18	High	23	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -				+	–
19	Low	23	9	,,	Penryn River oysters - - -	Characters of coli from lower dilution- -			+	–	

Examination of Penryn River Oysters.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

	3.					4.						5.
	Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.					B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures) per Oyster (average of 10 oysters). Cultures heated to 80° C. for 10 minutes.						Remarks.
Gas. Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium. + = acid and gas, 48 hours at 37° C.	Neutral-red broth cultures. + = greenish-yellow fluorescence. 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(a)	(b)									
+ N.L.	–	+	+	+	+			+	–			10 oysters measured 100 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+		+	–				10 oysters measured 95 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	–	+	–	+	–		+	–				10 oysters measured 110 c.c.
+ N.L.	–	+	–	–	+			+	–			10 oysters measured 100 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			+	–			10 oysters measured 110 c.c.
+ ? S.L.	+	+	+	+	+							
+ N.L.	–	+	+	+	+			+	–			10 oysters measured 100 c.c.
+ N.L.	–	+	–	+	+							
+ N,L.	–	+	–	+	+			+	–			10 oysters measured 110 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			×	–			10 oysters measured 110 c.c.
+ N.L.	+	+	–	+	+			+	–			10 oysters measured 110 c.c.
+ N.L.	–	+	–	–	+							
+ N.L.	–	+	–	+	+			+	–			10 oysters measured 105 c.c.
+ N.L.	+	+	+	+	+							
+ S.L.	–	+	–	–	–			+	–			10 oysters measured 115 c.c.
+ N.L.	+	+	–	+	+							
+? S.L.	+	+	+	+	+			+	–			10 oysters measured 120 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	–	+	+		+	–				10 oysters measured 120 c.c.
+ N.L.	–	+	+ slight	–	+							
+ N.L.	+	+	+	+	–			+	–			10 oysters measured 105 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			+	–			10 oysters measured 115 c.c.
+ N.L.	+	+	+	+	–							
+ N.L.	+	+	–	+	+			+	–			10 oysters measured 125 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	–	+	–	–	–			+	–			10 oysters measured 130 c.c.
+ N.L.	+	+	–	+	+							
+ N.L.	–	+	–	+ slight	–			+	–			10 oysters measured 100 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	–	+	+			+	–			10 oysters measured 130 c.c.
+ N.L.	+	+	+	+	+							

N.L. signifies that no liquefaction of the gelatine occurred (one month).
S.L. signifies that slow liquefaction of the gelatine occurred.

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

TABLE 6.—Showing the Results of the Bacteriological

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) per Oyster (average of 10 Oysters.)					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.							
20	High	25	9	1903	Penryn River oysters - - -					+	−
						Characters of coli from lower dilution- -					
21	Low	25	9	,,	Penryn River oysters - - -				+	−	
						Characters of coli from lower dilution- -					
22	High	29	9	,,	Penryn River oysters - - -					+	−
						Characters of coli from lower dilution- -					
23	Low	29	9	,,	Penryn River oysters - - -					+	−
						Characters of coli from lower dilution- -					
24	High	30	9	,,	Penryn River oysters - - -				+	−	
						Characters of coli from lower dilution- -					
25	Low	30	9	,,	Penryn River oysters - - -				+	−	
						Characters of coli from lower dilution- -					
								1 out of 25, 4 per cent.	13 out of 25, 52 per cent.	11 out of 25, 44 per cent.	

The numbers of the Samples as regards Oysters and Waters are in correspondence.

Examination of Penryn River Oysters—*continued.*

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

3. Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.						4. B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Kleins "enteritidis change" in anærobic milk cultures) per Oyster (average of 10 Oysters). Cultures heated to 80° C. for 10 miuutes.						5
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium. + = acid and gas, 48 hours at 37° C.	Neutral red, broth cultures. + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	REMARKS.
		(a)	(b)									
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +			+	–			10 oysters measured 120 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +			+	–			10 oysters measured 115 c.c.
+ N.L. + N.L.	– +	+ +	+ +	+ +	+ +				+			10 oysters measured 110 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +				+			10 oysters measured 120 c.c.
+ N.L. + N.L.	– +	+ +	– +	+ +	+ +			+	–			10 oysters measured 105 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +			+	–			10 oysters measured 100 c.c.
All positive, 100 per cent.	34 out of 48 positive, 70 per cent.	48 out of 48 positive, 100 per cent.	32 out of 48 positive, 66 per cent.	43 out of 48 positive, 89 per cent.	42 out of 48 positive, 87 per cent.		3 out of 25, 12 per cent.	20 out of 25, 80 per cent.	2 out of 25, 8 per cent.			
All positive, 100 per cent.	14 out of 25 positive, 56 per cent.	25 out of 25 positive, 100 per cent.	13 out of 25 positive, 52 per cent.	22 out of 25 positive, 88 per cent.	20 out of 25 positive, 80 per cent.							

N.L. signifies that no liquefaction of the gelatine occurred (one month).

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

The method of examination is fully described in Part V. Add. A.

Results as regards the presence of B. coli or coli-like microbes in the Penryn Oysters—

The results are shown in Table 6 and Diagram 3.

1 out of 25 (4%) contained 100 B. coli or coli-like microbes per oyster.*
13 out of 25 (52%) contained 1,000 B. coli or coli-like microbes per oyster.
11 out of 25 (44%) contained 10,000 B. coli or coli-like microbes per oyster.

The biological attributes of the various strains of B. coli are shewn in Table 6. Possibly the coli-like microbes isolated from the oysters were slightly less positive in their characters than the coli-like microbes derived from the water over the oysters. But the percentage number of coil-like microbes giving positive response to all, or most, of the tests for typical B coli was quite as high as might be expected in the case of a water known to be polluted with sewage.

Excluding extreme results, it would not be remote from the truth to say that the oysters are apt to contain 100 times more coli-like microbes than the water, reckoning per c.c. of oyster. The remarkable distinction between the biological quality of the oysters and water over the oysters, it would appear, is even more apparent at Penryn than at Helford. If it could be established as a law, that oysters were apt to be 100 times more impure than the water over the oysters, it would be the more intelligible why shell-fish seem, in my opinion, to be dangerous out of proportion to the *degree* of surrounding pollution. It is, at all events, quite clear that oysters are apt to contain per unit of volume B. coli or coli-like microbes in number greatly exceeding the coli contents of the surrounding water. To put the matter in a graphic manner it may be said that, apart from the saline contents of the sea water, it would seem that any *potential* danger to health involved in eating one Penryn oyster (of 10 c.c. capacity) is, broadly speaking, equivalent, *qua* bacteriological facts, to drinking 1,000 c.c. of Penryn water.

Results as regards the presence of B. enteritidis sporogenes in the Penryn Oysters. (Table 6 and Diagram 4.)

The results may be summarised as follows :—

3 out of 25 (12 %) contained 10 spores of B. enteritidis sporogenes.*
20 out of 25 (80 %) contained 100 spores of B. enteritidis sporogenes.
2 out of 25 (8 %) contained 1,000 spores of B. enteritidis sporogenes.

The results are markedly higher than the Helford records.

The following is a brief summary of the results of the bacteriological examination of the water and oysters :—

Description of sample.	Number of B. coli per c.c. of water, per oyster and per c.c. of oyster.						Number of spores of B. enteritidis sporogenes per c.c. of water, per oyster and per c.c. of oyster.			
	+ in 10 c.c.	1	10	100	1,000	10,000	Less than 10	10	100	1,000
Penryn water, 25 samples.	+ 16 %	+ 36 %	+ 44 %	+ 4 %			– 44 %	+ 56 %		
Penryn oysters, 25 batches of 10. Results stated as number per oyster.				+ 4 %	+ 52 %	+ 44 %		+ 12 %	+ 80 %	+ 8 %
Penryn oysters, 25 batches of 10. Results stated as number per c.c. of oyster.			+ 4 %	+ 52 %	+ 44 %		Less than 10 but at least 1 per c.c. 12 %	+ 80 %	+ 8 %	

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* To obtain approximate results for c.c. of oysters, divide the above results by 10.

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

The remarkable distinction between the water and oysters, both as regards the B. coli and the B. enteritidis sporogenes tests, is clearly shown in the foregoing table. *There can be no question that the two tests taken together yield more useful information than if the B. coli test had alone been employed.*

It remains only to compare as carefully as possible the Helford and Penryn results both as regards water and oysters.

PART III.

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

COMPARISON BETWEEN THE HELFORD AND PENRYN RESULTS.

In instituting this comparison, it is necessary to recall the remarks that have been made respecting the relation between the topographical features and bacteriological results in connection with each place.

Helford River :—

As regards the Helford River, it has been pointed out that there may be hitherto unsuspected sources of contamination, and that there were in reality minor sources of pollution, *e.g.*, the presence of yachts in the immediate vicinity of the layings. Nevertheless it is difficult to escape the practical conclusion that the Helford River is one of the purest, if not the purest, of regions around our coasts for oyster layings. To condemn the Helford River would be out of the question if oyster culture is to be allowed to continue, and would be almost equivalent to saying that no place in England was sufficiently pure for the growth and fattening of shell-fish. It is true that B. coli and coli-like microbes are absent from 100 c.c. of multiple samples of unpolluted sea water (Division III.) Such observations are of importance as showing that coli-like microbes form no necessary elements of the bacterial flora at the surface of pure sea water. But these samples were obtained for the most part, if not entirely, from localities practically unsuitable, if not impossible, for the growth and fattening of oysters for the market. It was not contended that in close proximity to land in comparatively shallow water and in regions suitable for oyster culture similar results would have been obtained. Indeed, drawing from the experience gained at Helford and other places it may be doubted whether around the English coast, contiguous to land, shallow water attaining a high standard of biological purity could readily be found.* Practically the conclusion seems to be that upon our coasts a certain degree of biological impurity must be accepted as inevitable, and that no sample should be condemned which does not exceed some permissible limit of impurity. But where to fix such limit is another question. All this leads to the final remark that, despite the bacteriological results, the Helford River must be accepted on topographical grounds as an example of one of the purest rivers in England for the growth and fattening of oysters.

Penryn River :—

In the foregoing paragraph the greatest care has been taken to avoid impugning a locality merely to correspond with the ascertained bacteriological facts. But as regards the Penryn river, the converse side of the question must be insisted on. That is, that despite the gross pollution of the Penryn river in its upper reaches and the localised areas of serious contamination, the fact remains that the general body of water in the inner Falmouth Harbour, and within the confines of the investigation, did not abound in intestinal microbes. In point of fact, the water was usually found to be from ten thousand to one hundred thousand times purer than sewage. Hence, in instituting comparisons, it must be remembered that, if the Helford River be conceded to be pure, the Penryn River must not necessarily be classed as *seriously* polluted (*qua* bacteriological facts) in the neighbourhood of the oyster layings chosen for the investigation. Before leaving the subject, it needs to be remembered in considering, on the one hand, topographical observations, and on the other, bacteriological investigations, that no true comparison is possible. Terms such as grossly, seriously, slightly, appreciably polluted, and so forth have no real definitive value. No topographist would venture, for example, to say that by "gross pollution" he meant the presence of say, ten per cent. of sewage; by "seriously polluted" the presence, for

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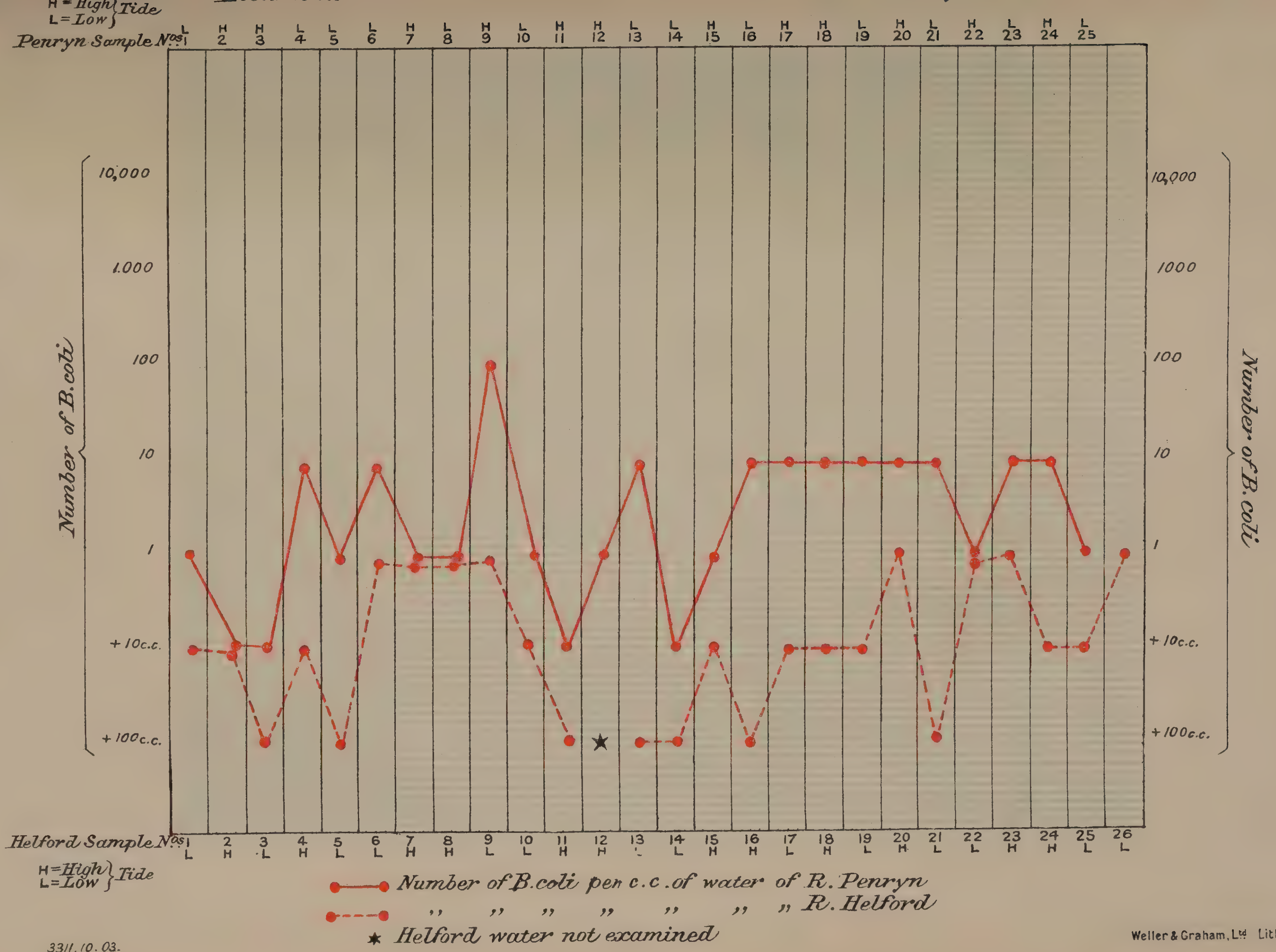
* It may be that in Ireland, estuarial waters attaining the highest standard of bacteriological purity are to be found.



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Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

instance, of one per cent. of sewage; or in general to render his statements strictly comparative in character.* The bacteriologist, on the other hand, if he lays bare all his facts, and if his results are quantitative as well as qualitative, must be prepared to let them stand the brunt of comparative scrutiny which may be prejudiced and even sometimes hypercritical in character. The more honest and detailed the statement of facts, the more open, in a sense, to criticism may be the results, and the more likely are seeming anomalies to invite attention. The range, breadth, practical utility and primary importance of topographical observations may be admitted without prejudice to the validity of the foregoing remarks.

There are a number of ways of comparing, both as regards waters and oysters, the Helford and Penryn bacteriological results

1. *The average method*, or method of comparing the average results with or without inclusion of the extreme figures.

2. *The percentage method*, or method of comparing all the results from the one place with all the results from the other place on a percentage basis of comparison.

3. *The extreme method*, or method of comparing the best and worst results from the one place with the best and worst results *respectively* from the other place.

4. *The drastic method*, or method of comparing the worst results from the "good" place (Helford) with the best results from the "bad" place (Penryn).

5. *The sanguine method*, or method of comparing the best results from the "good" place (Helford) with the worst results from the "bad" place (Penryn).

All these methods with the exception of the last will be employed. It is true that if it be proper to use the *drastic* method it might be considered fair to employ the *sanguine* method. But such a line of reasoning is based on unsound principles and cannot be entertained.

Comparison between the Helford and Penryn waters over their respective Oyster Layings.

B. Coli or Coli-like microbes (*see* Diagram 5).

1. Excluding extreme results, a fair average would be, as regards Penryn water, 1 to 10 coli-like microbes per c.c.

   In respect of Helford, I am inclined to think that the real average lies between + 10 c.c. and + 100 c.c., but as in eight of the samples coli-like microbes were present in 1 c.c., it may be said that 1 coli-like microbe per 10 c.c. is a fair statement of results. It is, at all events, certain that the Penryn water was more than ten times as impure, on the average, than the Helford water.

2. The percentage method may be expressed in tabular form as follows :—

Description of sample.	B. Coli, or coli-like microbes in :—				
	100 c.c.	10 c.c.	1 c.c.	0·1 c.c.	0·01 c.c.
Penryn River - -	—	Positive result. 16 %	Positive result. 36 %	Positive result. 44 %	Positive result. 4 %
Helford River -	Positive result. 28 %	Positive result. 40 %	Positive result. 32 %		

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* This remark, of course, in no sense implies disbelief in the primary importance and practical utility of topographical observations.

Division IV.

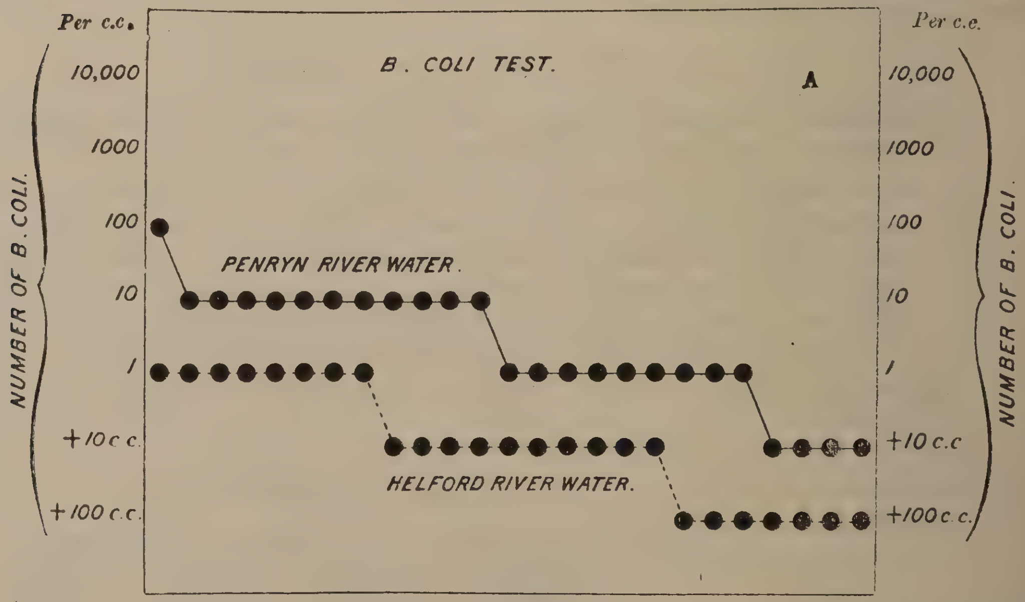
Bacteriological Examination of the Helford and Penryn Water and Oysters.

3. As regards the "extreme" method, it is seen above that one (4 sample contained 100, and eleven (44 %) samples 10, B. coli or co like microbes per c.c. of Penryn water, whereas the eight (32 samples of Helford water yielding the worst results contained one B. coli or coli-like microbe per c.c.

Four (16 %) samples of Penryn water contained one B. coli or coli-like microbe per 10 c.c., whereas the seven (28 %) samples of Helford water yielding the best results contained only one B. coli or coli-like microbe per 100 c.c.*

4. As regards the drastic method of comparison, the four (16 %) best samples of Penryn water contained one B. coli or coli-like microbe per 10 c.c., whereas the eight worst samples (32 %) of Helford water contained one B. coli or coli-like microbe per 1 c.c.†

If, to the above results, the 1 c.c. standard (fourth class, *see* Division III.) suggested tentatively in the Report on Unpolluted Sea Water is applied, and if all the coli-like microbes are placed in one class, then it will be found that 21 out of 25 (84 %) of the Penryn and 8 out of 25 (32 %) of the Helford samples would have been condemned. Pursuing the matter a little further, 1 sample (4 %) of Penryn water belonged to the sixth class; 11 samples (44 %) of Penryn water to the fifth class; 10 samples (40 %) of Helford water to the second class. Lastly, taking the best results from Penryn and the worst results from Helford, 4 (16 %) of the samples of Penryn water would have been "passed," although coming from a locality topographically objectionable, whereas 8 (32 %) of the samples of Helford water would have been condemned, although derived from a source topographically seemingly above suspicion.‡ This is the worst construction that could be placed on the results, and it seems only fair to conclude by saying that on the average Penryn water was, as a matter of fact, more than ten times as impure as the Helford water. The lesson to be learnt is that multiple samples of water should be examined before coming to other than tentative conclusions as regards the biological quality of a water from a particular locality. In the following diagram (A) the B. coli results are arranged in each case from the highest to the lowest:—



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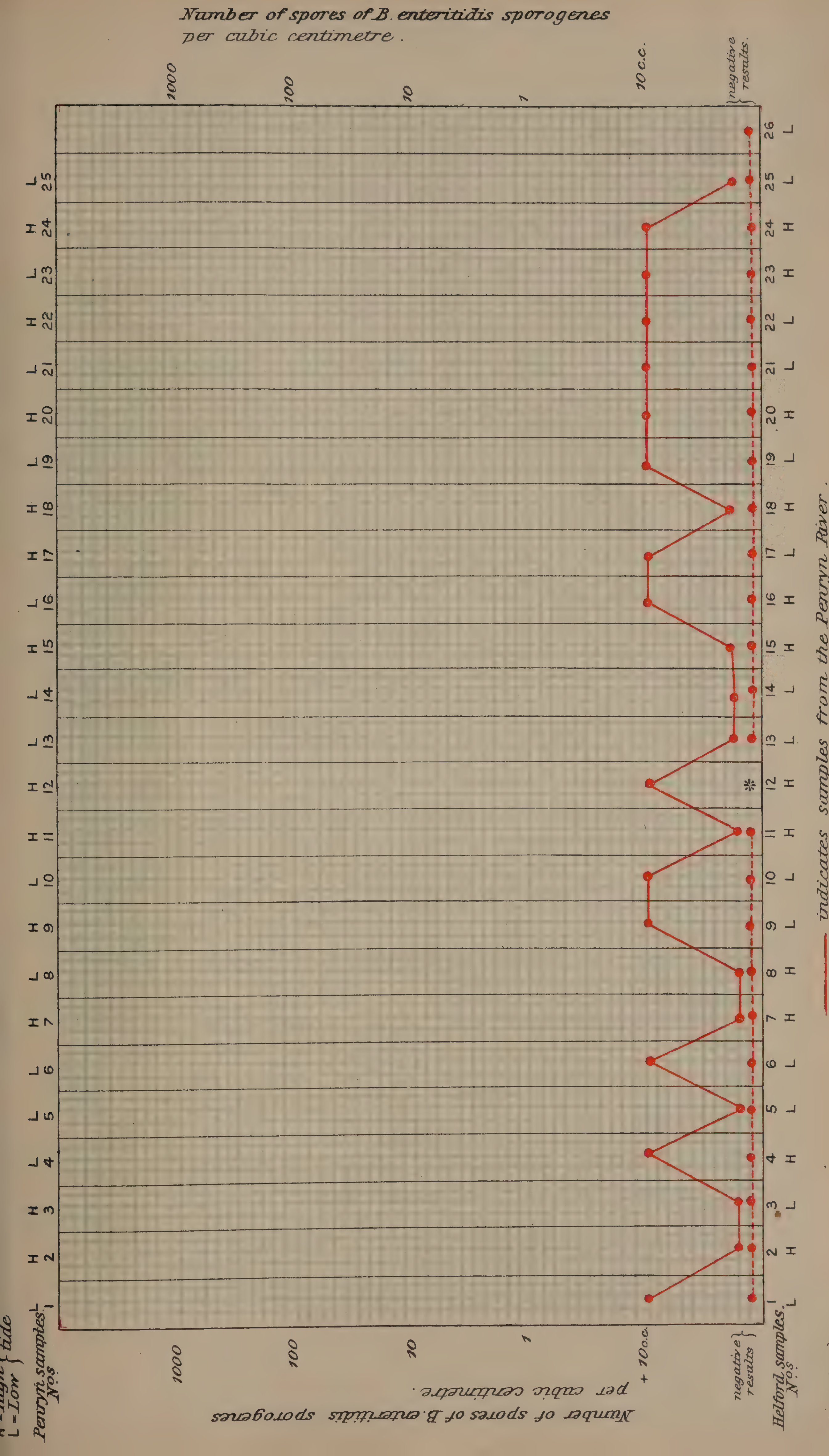
* That is on the basis of results. No intermediate distinctions between + 100 c.c. and + 10 c.c.; + 10 c.c. and + 1 c.c.; + 1 c.c. and + ·1 c.c., etc., etc., are drawn.

† It needs to be remembered that the comparison of chance samples of tidal waters from separate estuaries is apt to be most misleading.

‡ To make the standard ten times more lenient would involve the "passing" of waters open to serious objection.



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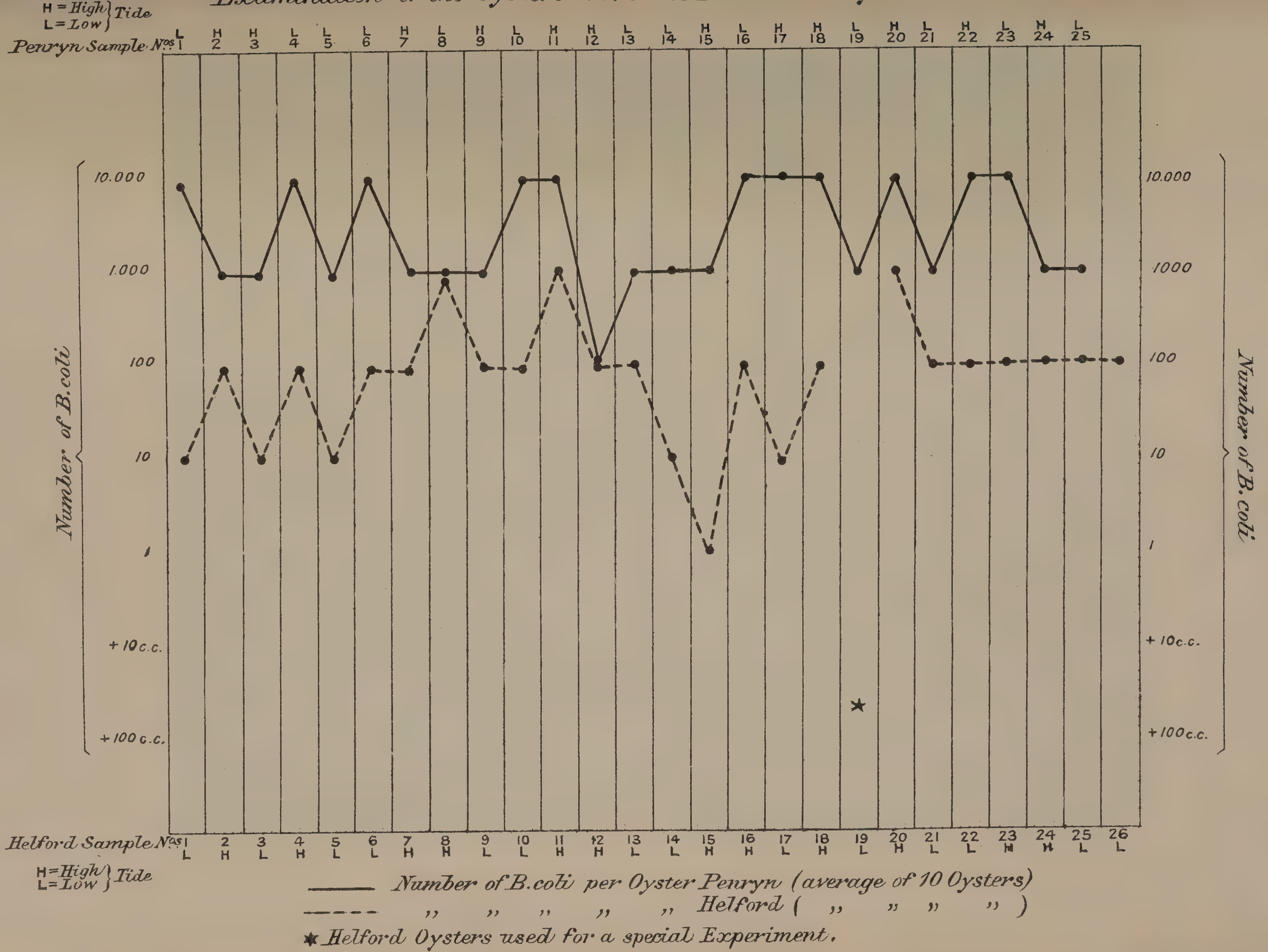

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Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters

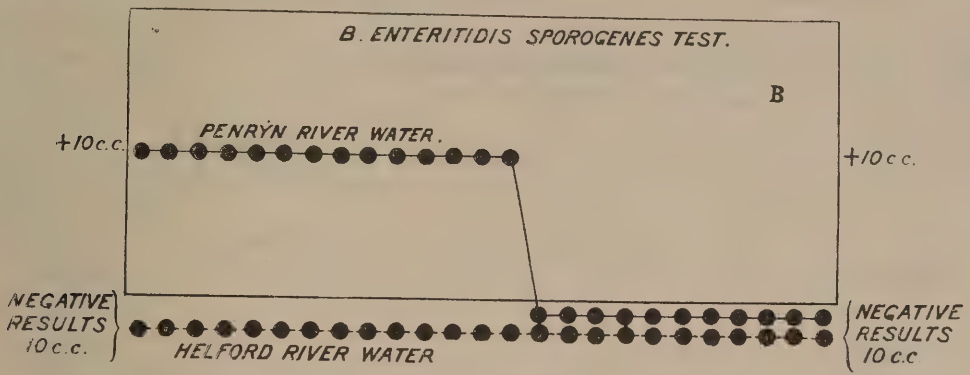
B. Enteritidis Sporogenes (*see* Diagram 6).

Practically speaking, the most satisfactory method of comparing the results is as follows :—

Penryn river - - -	56 %	Positive result, 10 c.c. of sample.
	44 %	Negative result, 10 c.c. of sample.
Helford river - - - -	100 %	Negative result, 10 c.c. of sample.

The distinction is striking, but, again adopting the method of putting the worst construction possible on the results, it may be said that if single samples had been examined, although a Helford sample would certainly have yielded a negative result, the chances that a single Penryn sample would have given a positive result were only about equal. In point of fact, the results might have been, apart from technical difficulties, even more satisfactory. Had it been practicable to make 100 c.c. cultures of both waters all the Penryn waters might have yielded positive results and a majority of the Helford waters a negative result. If, for the purposes of a broad comparison, it is *tentatively* suggested that water should be condemned yielding a positive result with 10 c.c , then all the Helford waters passed this standard, and 56 % of the Penryn waters stand condemned.

The results are arranged in each case from the highest to the lowest, in the following diagram (B) :—



COMPARISON BETWEEN THE HELFORD AND PENRYN OYSTERS.

B. Coli or Coli-like Microbes (*see* Diagram 7).

1. Excluding extreme results, a fair average would be as regards Penryn 1,000 to 10,000, and in respect of Helford 10 to 100 B. coli or coli-like microbes per oyster.* On the average the Penryn oysters were about 100 times more impure (bacteriologically) than the Helford oysters.
2. The percentage method of comparison may be expressed in tabular form as follows :

Description of Sample.	B. Coli or coli-like microbes per oyster.				
	1	10	100	1000	10,000
Penryn oysters - - - -	—	—	4%	52%	44%
Helford oysters - - - -	4%	20%	64%	12%	—

3. As regards the "extreme" method, it is seen above that one sample (4%) of Penryn oysters contained only 100 B. coli or coli-like microbes per oyster. The rest varied from 1,000 (52%) to 10,000 (44%). One sample (4%) of Helford oysters contained only 1 coli-like microbe per oyster. The three worst samples (12%) contained 1,000. The rest varied from 10 (20%) to 100 (64%).

---

* To obtain approximate results per c.c. of oyster, divide the foregoing figures by 10.

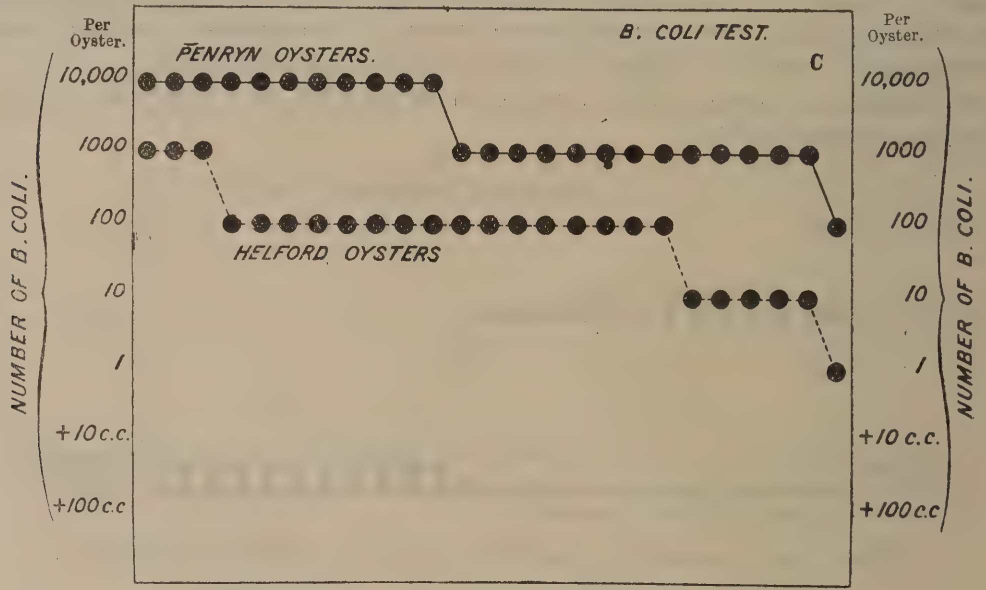
Division IV.
Bacteriological Examination of the Helford an Penryn Water and Oysters.

4. As regards the drastic method, it appears that one (4°/₀) sample (the best) of Penryn oysters contained 100 B. coli or coli-like microbes per oyster, whereas the three (12°/₀) worst samples of Helford oysters contained 1,000 B. coli or coli-like microbes per oyster.

If, for the purpose of a broad comparison, it is *tentatively* suggested that oysters should be condemned containing 1,000 B. coli or coli-like microbes *per oyster* (approximately 100 per c.c. of oyster) then the following facts are revealed :—

Penryn- - - -	One sample (4°/₀) passed this standard. 24 samples (96°/₀) were condemned.
Helford - - -	22 samples (88°/₀) passed this standard. 3 samples (12°/₀) were condemned.

In the following diagram (C) the results arranged in each case from the highest to the lowest are set forth :—



B. Enteritidis Sporogenes (*see* Diagram 8).

Here the best method of comparison will be to give the percentage number of samples of Penryn and Helford oysters which fall under one or other of the following categories :—

1,000 per oyster - - -	8°/₀ of the Penryn oysters.
100 per oyster - - -	80°/₀ of the Penryn oysters and 4°/₀ of the Helford oysters.
10 per oyster - - -	12°/₀ of the Penyrn oysters and 32°/₀ of the Helford oysters.
Less than 10 per oyster -	*none* of the Penryn oysters and 64°/₀ of the Helford oysters.

It will be seen that this test proved of real value in drawing a wide distinction between the biological quality of the Penryn and Helford oysters respectively.

If, for the purposes of a *broad* comparison, it is *tentatively* suggested that oysters should be rejected when containing 100 B. enteritidis sporogenes per oyster (approximately 10 per c.c. of oyster), then the following facts are revealed :—

Penryn - - - -	3 samples (12°/₀) passed this standard. 22 samples (88°/₀) were condemned.
Helford - - - -	24 samples (96°/₀) passed this standard. 1 sample (4°/₀) was condemned.

Again resorting to the drastic method of comparison, it may be pointed out that whereas the three best samples (12°/₀) of Penryn oysters contained only 10 spores, one (the worst) sample (4°/₀) of Helford oysters contained 100 spores of B. enteritidis sporogenes.

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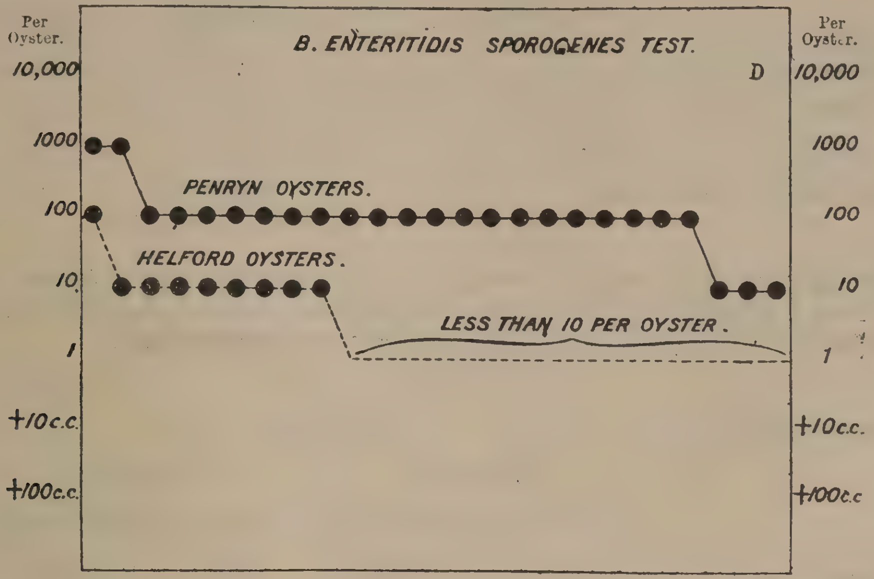
Bacteriological Examination of the Helford and Penryn Water and Oysters.

In the following diagram (D) the results arranged in each case from the highest to the lowest are set forth :—



The results would seem to suggest that the B. enteritidis sporogenes test indicated as decided a difference between the Penryn and Helford oysters as did the B. coli test. In point of fact, the distinction may have been even more in favour of the B. enteritidis sporogenes test, inasmuch as in no less than 16 (64%) of the Helford samples no positive result (for technical reasons) was obtained.

SUMMARY OF THE FOREGOING RESULTS AS REGARDS WATER AND OYSTERS.

B. coli test :—	Water.		
	Penryn.		Helford.
100 B. coli or coli-like microbes per c.c. -	4 %	-	None.
10 ,, ,, ,, ,, -	44 %	-	None.
1 ,, ,, ,, ,, -	36 %	-	32 %
B. coli or coli-like microbes present in 10 c.c.	16 %	-	40 %
,, ,, ,, 100 c.c.	—	-	28 %
B. enteritidis sporogenes test :—			
Positive result 10 c.c. of sample - -	56 %	-	None.
Negative ,, ,, ,, - -	44 %	-	All.

Adopting the view, *solely for comparative purposes*, that a water should not contain B. coli in 1 c.c., or yield a positive result with the B. enteritidis sporogenes test with 10 c.c. of the sample, then :—

	Water.			
	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test - -	16 %	84 %	68 %	32 %
B. enteritidis sporogenes test	44 %	56 %	100 %	None.

B. coli test :—	Oysters.		
	Penryn.		Helford.
10,000 B. coli or coli-like microbes per oyster	44 %	-	None.
1,000 ,, ,, ,, ,,	52 %	-	12%
100 ,, ,, ,, ,,	4 %	-	64 %
10 ,, ,, ,, ,,	—	-	20 %
1 ,, ,, ,, ,,	—	-	4 %

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

B. enteritidis sporogenes test :—

	Oysters.		
	Penryn.		Helford.
1,000 per oyster	8 %	-	None.
100 ,, ,,	80 %	-	4 %
10 ,, ,,	12 %	-	32 %
Less than 10 per oyster	None.	-	64 %

Adopting the view, *solely for comparative purposes,* that an oyster should not contain 1,000 B. coli or 100 spores of B. enteritidis sporogenes *per oyster* (approximately 100 and 10 respectively *per c.c.* of oyster), then :—

Lenient Standard :—

	Oysters.			
	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test	4 %	96 %	88 %	12 %
B. enteritidis sporogenes test	12 %	88 %	96 %	4 %

A more stringent standard would be less than 100 B. coli or 10 spores of B. enteritidis sporogenes per oyster (approximately 10 and 1 respectively *per c.c.* of oyster), then :

Stringent Standard.

	Oysters.			
	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test	None	100%	24%	76%
B. enteritidis sporogenes test	None	100%	64%	36%

STANDARDS, AS REGARDS OYSTERS, BASED ON AN ATTEMPT TENTATIVELY TO LINK TOGETHER THE QUANTITATIVE AND QUALITATIVE RESULTS—

An attempt is now about to be made to compare the Penryn and Helford oysters, as regards the B. coli test, both quantitatively and qualitatively.

Interpretation of B coli :—

It will be remembered that the quantitative results have been founded on the number of gas-forming coli-like microbes of all sorts present in the sample, and, further, that the biological characters of the coli-like characteristic of the last dilution but one (made in successive tenths), as well as those of the last dilution* have in each case been determined. Now, if it be insisted on arbitrarily that a coli-like microbe to be ranked as B. coli must yield a positive result with *at least three out of the four tests* (neutral-red broth, lactose peptone, litmus milk and indol) employed throughout the investigation ; and, further, if for the sake of always recording a positive result it be *tentatively assumed* that the few samples wherein the coli-like microbes isolated both in the last and last-dilution-but-one failed to conform to this standard, contained nevertheless in all probability

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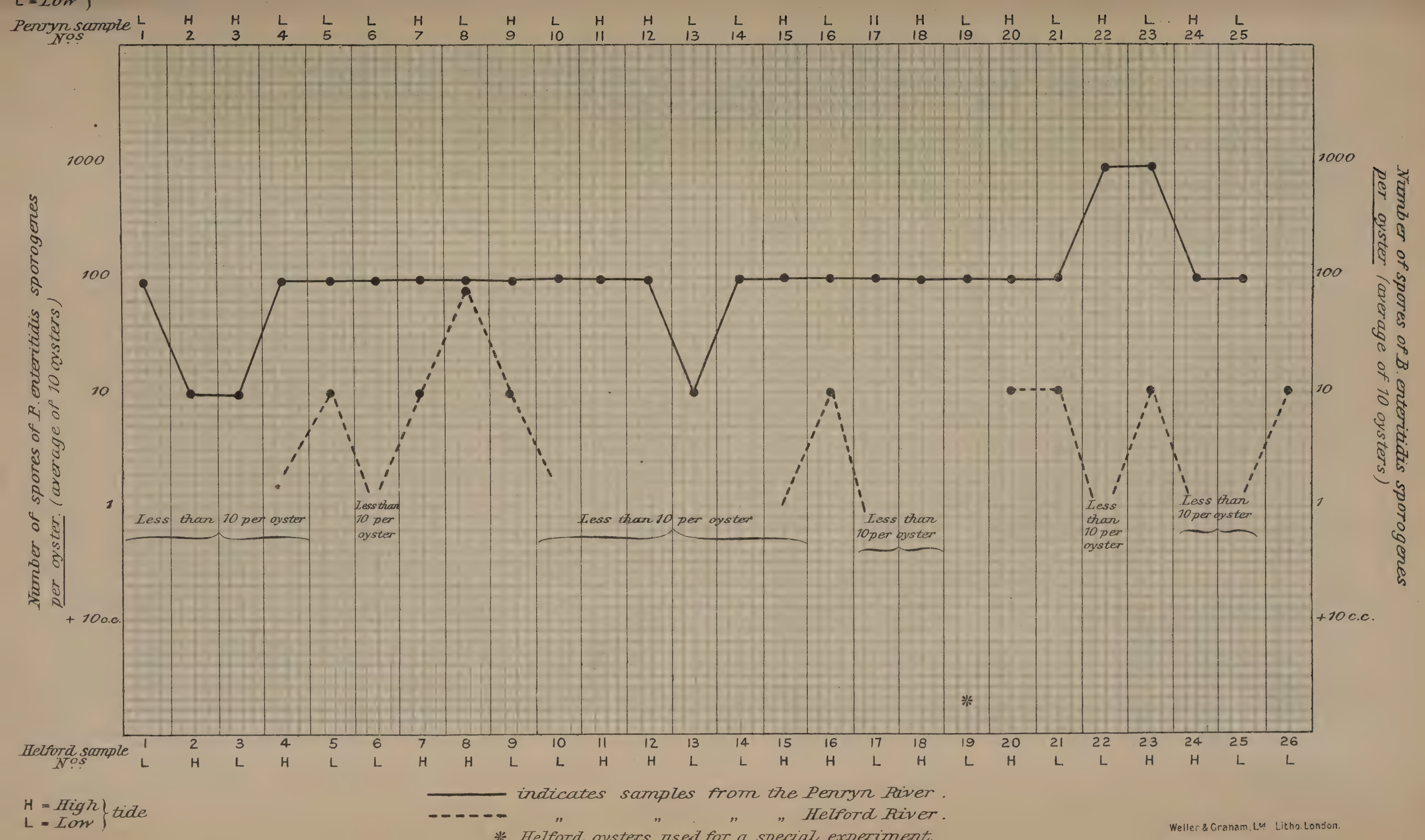
* The " last dilution " means the ast dilution yielding coli-like microbes out of a series of dilutions made in successive tenths.


L = Low }
Penryn sample N°s
L 1
H 2
H 3
L 4
L 5
L 6
H 7
L 8
H 9
L 10
H 11
H 12
L 13
L 14
H 15
L 16
H 17
H 18
L 19
H 20
L 21
H 22
L 23
H 24
L 25
Number of spores of B. enteritidis sporogenes per oyster (average of 10 oysters)
1000
100
10
1
+ 10c.c.
Less than 10 per oyster
Less than 10 per oyster
Less than 10 per oyster
Less than 10 per oyster
Less than 10 per oyster
Less than 10 per oyster
*
Helford sample N°s
1 L
2 H
3 L
4 H
5 L
6 L
7 H
8 H
9 L
10 L
11 H
12 H
13 L
14 L
15 H
16 H
17 L
18 H
19 L
20 H
21 L
22 L
23 H
24 H
25 L
26 L
H = High } tide
L = Low }
indicates samples from the Penryn River.
" " " " Helford River.
* Helford oysters used for a special experiment.
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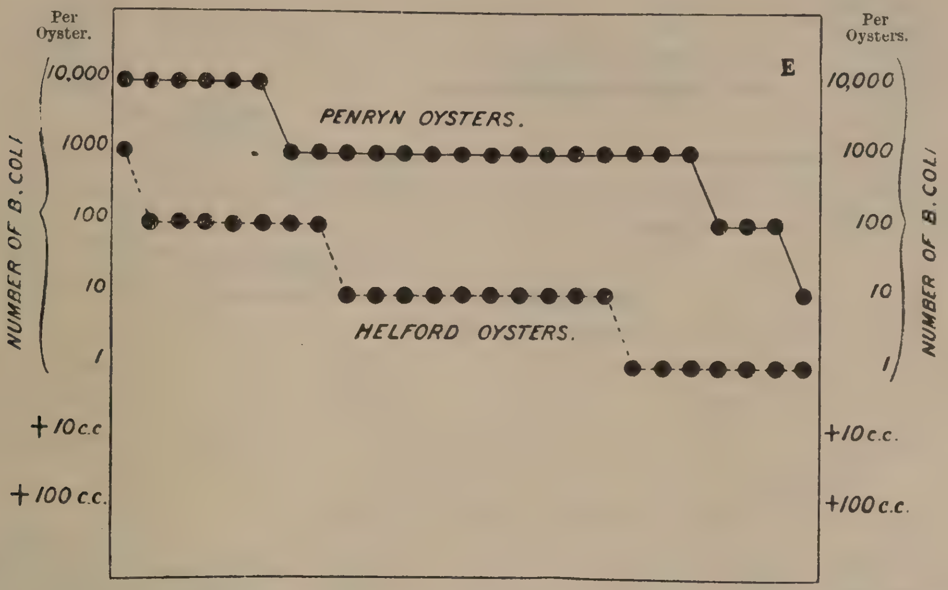
Bacteriological Examination of the Helford and Penryn Water and Oysters.

in the last-dilution-but-two coli-like microbes capable of giving positive results with three out of the four tests,[*] it is then possible (Modification No. 1.) to construct a comparative diagram (E) as follows [†]:—



It is to be noted (see previous diagram C.) that the effect of this arbitrary method of treating the results is to place both the Penryn and the Helford oysters at less disadvantage.

That this is true will be gathered from the following amended table of percentages :—

B. coli test (modification No. 1.) :—	Oysters. Penryn.	Oysters. Helford.
10,000 B. coli per oyster	24 %	None
1,000 ,, ,,	60 %	4 %
100 ,, ,,	12 %	28 %
10 ,, ,,	4 %	40 %
1 ,, ,,	—	28 %

Now, if to these modified figures we apply the lenient and stringent standards (less the 1,000 and less than 100 B. coli respectively per oyster), we get the following results :—

Lenient standard (less than 1,000 per oyster).

	Penryn. Passed.	Penryn. Condemned.	Helford. Passed.	Helford. Condemned.
B. coli test	16 %	84 %	96 %	4 %

Stringent standard (less than 100 per oyster).

	Penryn. Passed.	Penryn. Condemned.	Helford. Passed.	Helford. Condemned.
B. coli test	4 %	96 %	68 %	32 %

Further, by way of another comparison on a different assumption, only those records will be utilised in which either from the last or the last-dilution-but-one coli-like microbes were isolated which on the basis of yielding completely positive results with all the tests employed were indistinguishable from the typical B. coli of human intestinal origin (Modification No. 2.).

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[*] The fact that, although a typical B. coli is oftener obtained in a lower than in a higher dilution, the converse not uncommonly occurs, suggests that in many cases when the particular coli-like microbe selected for subculture turns out to be atypical, this may be due not necessarily to the absence of the more typical or completely typical forms in the same or in a lower dilution, but to the mere accident of chance involved in the speculative selection of a colony for subculture without any previous knowledge of its biological attributes.

[†] It will be understood that the results as regards total number of coli-like microbes are sometimes divided by ten and sometimes by 100. By ten, if the coli-like microbes isolated from the last dilution failed as regards two or more of the four tests. By 100, if a similar result was obtained in respect of the last dilution-but-one.

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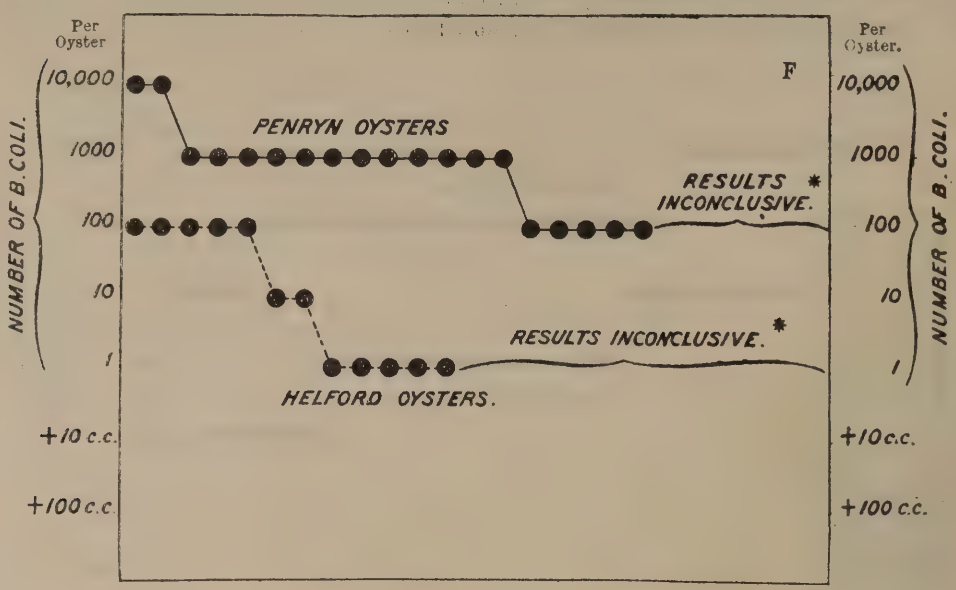
Bacteriological Examination of the Helford and Penryn Water and Oysters.

The results on this other basis are shown in the following diagram (F) :—



In the first place these results may be interpreted on the arbitrary, and probably unwarrantable, assumption that the samples which did not yield completely typical results should be *unconditionally* "passed."

On this sweeping assumption, the results would be grouped, and the aforementioned lenient and stringent standards applied as follows :—

	Oysters.	
B. coli test (modification No. 2).	Penryn.	Helford.
10,000 B. coli per oyster - - - -	8 % -	None
1,000 ,, ,, - - - -	48 % -	None
100 ,, ,, - - - -	20 % -	20 %
10 ,, ,, - - -	[24 %*] -	8 %
1 ,, ,, - - -	— -	20 % [52 %*]

Applying to these modified figures the lenient and stringent standards (less than 1,000 and less than 100 B. coli respectively per oyster), the following results are obtained :—

Lenient Standard (less than 1,000 per oyster).

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test - - -	44 %	56 %	100 %	None

Stringent Standard (less than 100 per oyster).

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test - - -	24 %	76 %	80 %	20 %

Secondly, the foregoing results may be interpreted (Modification No. 3.) in the sense that the inconclusive results are ignored, and the percentages based solely and entirely on the samples yielding definite records. This is not a satisfactory method, since it would mean, in practice, that the bacteriologist would often fail to come to any decision favourable or the reverse.

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* Results inconclusive on a purely arbitrary basis, and therefore on this assumption to be "passed." That is, in 24 % and 52 % respectively of the Penryn and Helford samples of oysters the coli-like microbes isolated from either the last dilution or the last-dilution-but-one yielding coli-like microbes did not give *completely* positive results.

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

Under this method the results are as follows :—
B. coli test (modified as above).

	Oysters.	
	Penryn.	Helford.
10,000 B. coli per oyster	10 %	None.
1,000 ,, ,,	63 %	None.
100 ,, ,,	26 %	41 %
10 ,, ,,	—	16 %
1 ,, ,,	—	41 %

Applying to these modified figures the lenient and stringent standards (less than 1,000 and less than 100 B. coli respectively per oyster) the following results are obtained :—

Lenient Standard (less than 1,000 per oyster).

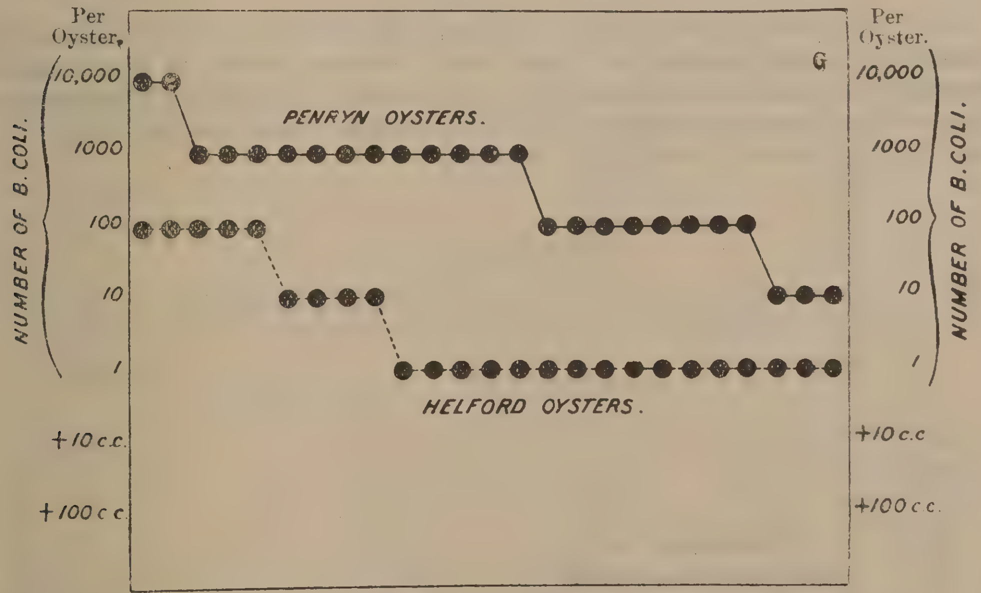
	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test	26 %	73 %	100 %	None.

Stringent Standard (less than 100 per oyster).

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test	None.	100 %	57 %	41%

It must be definitely understood that the B. coli test applied in this arbitrary manner leaves out of account 6 out of 25 (24 %) Penryn, and no less than 13 out of 25 (52 %) Helford oysters concerning which no bacteriological diagnosis is furnished.

This is such an obviously unsatisfactory interpretation of results that, in conclusion, a final grouping (Modification No. 4) may be attempted. In this case it may still be insisted that either in the last dilution, or in the-last-dilution-but-one, yielding coli-like microbes, these microbes must yield positive results with all four tests in order to be regarded as typical B. coli. When the last dilution fails in this respect, then the number of B. coli is based on the last-dilution-but-one. But when neither dilution contains typical B. coli the total number of coli-like microbes is divided by one hundred.



It will be noted that the results work out as follows :—
B. coli test (Modification No. 4).

	Oysters.	
	Penryn.	Helford.
10,000 B. coli per oyster	8 %	None.
1,000 ,, ,,	48 %	None.
100 ,, ,,	32 %	20 %
10 ,, ,,	12 %	16 %
1 ,, ,,	—	64 %

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

Again applying to these modified figures the lenient and stringent standards (less than 1,000 and less than 100 B. coli respectively per oyster) we get the following results :—

Lenient Standard (less than 1,000 per oyster).

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test - -	44 %	56 %	100 %	None.

Stringent Standard (less than 100 per oyster).

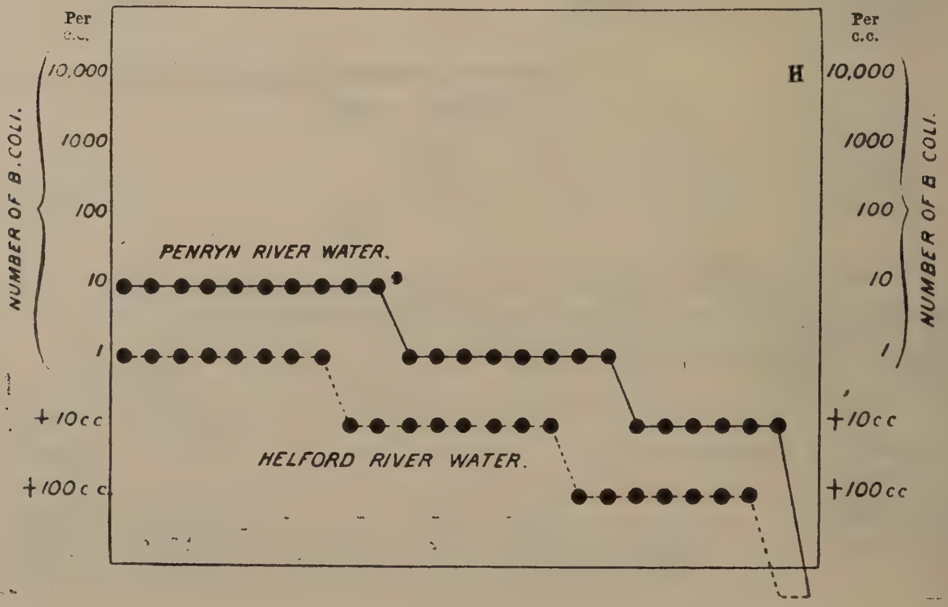
	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test - -	12 %	88 %	80 %	20 %

It is obvious, therefore, that in whatever way the results be interpreted the bacteriological distinction between the Helford and Penryn oysters is very great. Errors might indeed arise, if conclusions were based on the examination of isolated samples, but given the examination of multiple samples quantitatively and qualitatively there can be no question as to the relative value of the results. The only real difficulty that presents itself is the fact of the Helford oysters being much less free from B. coli or coli-like microbes than might be anticipated from the topographical surroundings of the layings. Further, the Helford oysters would seem to contain more coli-like microbes than samples of oysters obtained at a later date from other places—places, moreover, which appeared to be less favourably situated as regards possible contamination. It may be, of course, that for oysters there is a seasonal B. coli curve, a matter which may have to be investigated. It is evident from the Helford results that oysters should not be condemned unless they exceed a " permissible limit of biological impurity," but where the line should be drawn either quantitatively or qualitatively, and in what directions, is another matter.

STANDARDS, AS REGARDS WATER, BASED ON AN ATTEMPT TO LINK TOGETHER THE QUANTITATIVE ANN QUALITATIVE RESULTS.

Just as an attempt was made to present the oyster results on a combined quantitative and qualitative basis, so a similar effort is now made in connexion with the Helford and Penryn waters. It will be unnecessary to describe the bases governing the different modifications, as this has already been done in connexion with the oysters.

Modification No. 1.



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Bacteriological Examination of the Helford and Penryn Water and Oysters.

It will be noted that the results work out as follows :—

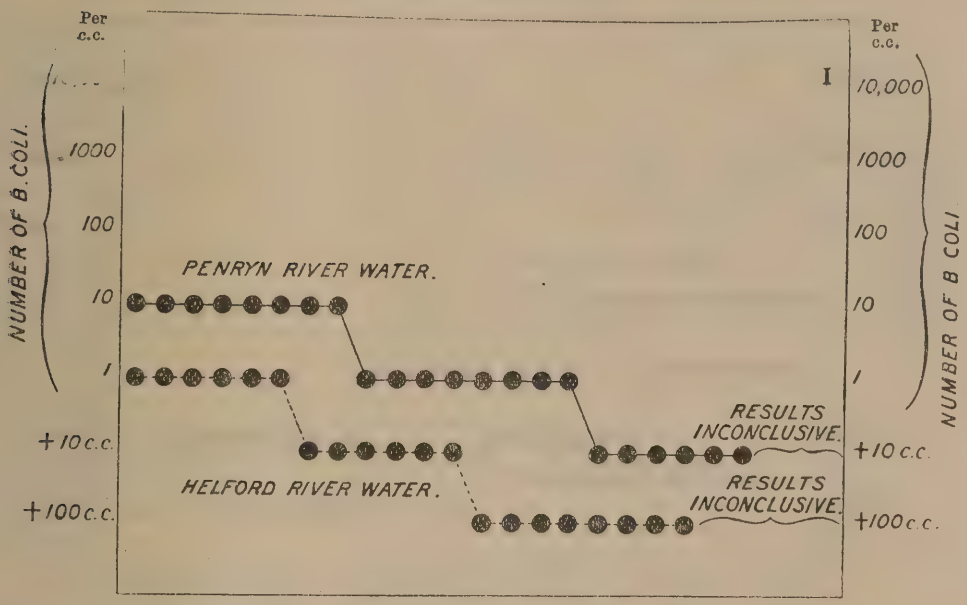
	Water.	
B. coli test (Modification No. 1) :—	Penryn.	Helford.
10 B. coli per c.c. - - - -	40 %	—
1 ,, ,, - - -	32 %	32 %
+ 10 c.c. - - - - - - -	24 %	32 %
+ 100 c.c. - - - - - -	—	28 %
– 100 c.c. - - - - - -	4 %	8 %

Applying to the foregoing modified results, the standard of less than 1 B. coli per c.c. of water, the following results are obtained :—

Standard (less than 1 B. coli per c.c.).

	Penryn.		Helford.	
	Passed.	Condemned	Passed.	Condemned.
B. coli test - - -	28 %	72 %	68 %	32 %

Modification No. 2



It will be noted that the results work out as follows :—

	Water.	
B. coli test (Modification No. 2)	Penryn.	Helford.
10 B. coli per c.c. - -	32%	—
1 ,, ,, - -	32%	24%
+ 10 c.c. - - - -	24%	24%
+ 100 c.c. - - - -	[12%*]	32% [20%*]

Applying to the foregoing modified results the standard of less than 1 B. coli per c.c. of water, the following results are obtained :—

Standard (less than 1 B. coli per c.c.)

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test	36%	64%	76%	24%

Modification No. 3.

	Water.	
B. coli test (Modification No. 3).	Penryn.	Helford.
10 B. coli per c.c. - -	36%	
1 ,, ,, - -	36%	30%
+ 10 c.c. - - - -	27%	30%
+ 100 c.c. - - - -		40%

---

* Results inconclusive on a purely arbitrary basis and therefore on this assumption to be "passed."

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Bacteriological Examination of the Helford and Penryn Water and Oysters.

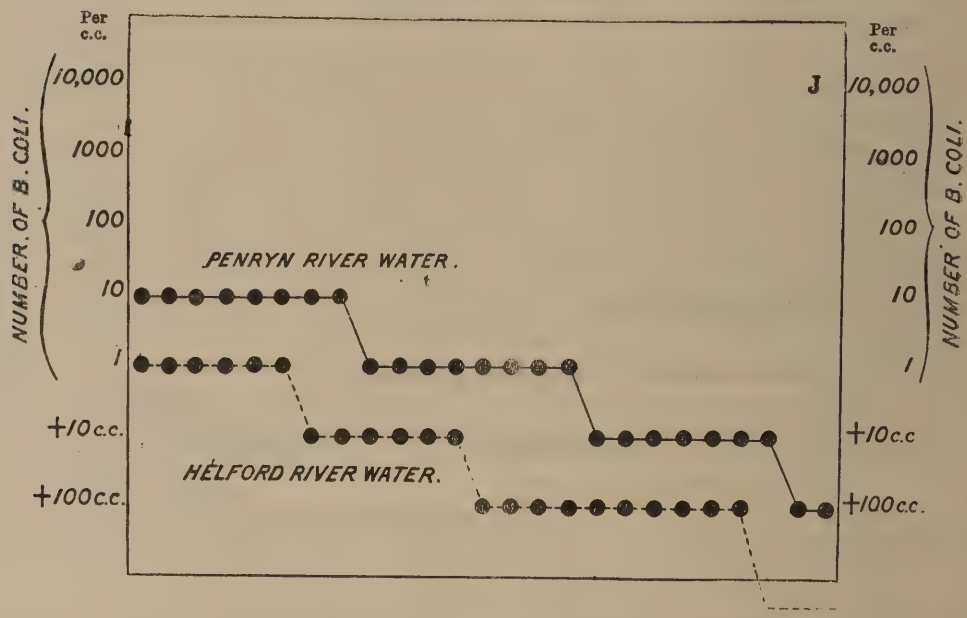
Applying to these modified results the standard of less than 1 B. coli per c.c. of water, the following results are obtained :—

Standard (less than 1 B. coli per c.c.)

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned,
B. coli test	27°/₀	72°/₀	70°/₀	30°/₀

It must be understood that the B. coli test applied in this arbitrary manner leaves 3 out of 25 (12°/₀) Penryn, and no less than 5 out of 25 (20°/₀) Helford waters concerning which bacteriological diagnosis is inconclusive..

Modification No. 4.



It will be noted that the results work out as follows :—

	Water.	
	Penryn.	Helford.
B. coli test (Modification No. 4).		
10 B. coli per c.c. - - -	32 °/₀	—
1 " " - - -	32 °/₀	24 °/₀
+ 10 c.c. - - - - -	28 °/₀	24 °/₀
+ 100 c.c. - - - - -	8 °/₀	40 °/₀ [12 °/₀*]

Applying to these modified figures the standard of less than 1 B. coli per c.c., the following results are obtained :—

Standard (less than 1 B. coli per c.c.).

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. coli test	36 °/₀	64 °/₀	76 °/₀	24 °/₀

It is obvious, therefore, that in whatever way the results are interpreted, the bacteriological distinction between the Helford and Penryn waters is great, although not so striking as is the distinction between the Helford and Penryn oysters.

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* These samples, on this basis, must needs be "passed" without reservation.

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

BACTERIOLOGICAL GROUPING OF OYSTERS IN CLASSES WITH TENTATIVE STANDARDS FOR COMPARATIVE PURPOSES.

In the division of this report (Division III.) dealing with the bacteriological examination of samples of unpolluted sea water, an attempt was made to group waters in classes for comparative purposes. Similarly, in this division, the oysters will be arranged in classes, but it must be definitely understood that *such classification is based on the collective examination of ten oysters on the lines laid down in this report* (*Add.* A.)

CLASS.*	Standard based on numerical abundance of B. Coli (or non-liquefying, gas-forming coli-like microbes), in the whole contents of the oyster shell (*i.e.* liquor, body and interior juices of the oyster).	Numerical standard confirmed or modified according to response of the coli-like microbes in pure *culture* to certain well-known biological tests.	Provisional bacteriological conclusions confirmed or modified by topographical observations.	Provisional bacteriological and topographical conclusions confirmed or modified by epidemiological and administrative considerations.
First Class. n oyster showing no evidence acteriologically) of objectionable contamination.	No B. Coli.	For example :— (1) *Neutral-red broth test* : — Greenish-yellow fluorescence (48 hours at 37° C. (2) *Lactose peptone test* :—Gas and acid production (48 hours) at 37° C. (3) *Indol test* :—Indol in broth cultures (5 days at 37° C. (4) *Litmus milk test* :—Acid clotting of milk (5 days at 37° C.) Of course, the more tests applied, the better, but the above are all known tests of value. ¶	For example : Dilution ; set of the tides ; prevailing winds ; float experiments ; time interval ; distance, etc., etc.	For example :— Questions of practicability ; whether the contaminating material is likely to have a high or a low enteric morbific value ; past epidemiological experience in circumstances broadly parallel, etc., etc.
Second Class. oyster showing appeciable, although ght, evidence acteriologically) of jectionable conmination.	1 B. Coli per oyster.†			
Third Class. yster, showing defite signs (bacteriogically) of pollution d, therefore, posly to be viewed ith some degree of spicion.	10 B. Coli per oyster.†			
Fourth Class. An oyster showing such obvious signs (bacteriologically) of pollution as to be condemned on a stringent standard.	100 B. Coli per oyster.†			
Fifth Class. An oyster showing such unmistakeable evidence (bacteriologically) of pollution as to be condemned on the basis of results. §	1,000 B. Coli per oyster.†			
Sixth Class. oyster showing ch *gross* evidence acteriologically) of ntamination as to e outside the pale of cognition.	10,000 B. coli per oyster.†			

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* It must, of course, be definitely understood that it cannot be said either that oysters of the second, or even class are necessarily always safe, or that oysters of the third, fourth, fifth or sixth class have a definite disease value.

† To obtain approximate results *per c.c.* of oyster, divide the foregoing figures by ten.

§ This does not mean administrative, practical, or legislative condemnation, but only that the evidence of pollution fficiently defined to merit objection from the bacteriologist's point of view.

¶ As regards tests (1) (2) (3) and (4) my work for the Local Government Board on the B. coli of recently-voided normal an fæces shows that of 100 B. coli, 98, 92, 98, and 92 per cent. yielded positive results in each instance to one or other As regards all four tests (taken in conjunction) 85 % yielded positive results.

As regards the B. enteritidis sporogenes test, a lenient standard would seem to be less than 100 spores of this anaerobe *per oyster*. A more stringent standard would be less than 10 spores *per oyster*.

PART IV.

CONCLUSIONS.

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

On the one hand, the water of an estuarial river, such as the Helford River, which, on topographical grounds, has been, and would still be considered eminently well suited for the breeding, growth, and fattening of oysters for market, may contain B. coli or coli-like microbes, in 100 c.c. (28 %), in 10 c.c. (40 %), or in 1 c.c. (32 %). As regards B. enteritidis sporogenes all the samples yielded a negative result when using for cultural purposes 10 c.c. of the water.

Oysters obtained from the Helford River contained B. coli or coli-like microbes in greater number than did comparable quantities of the surrounding water: 1,000 per oyster, about 100 per c.c. of oyster, (12 %); 100 per oyster, about 10 per c.c. of oyster, (64 %); 10 per oyster, about 1 per c.c. of oyster, (20 %); 1 per oyster (4%). As regards spores of B. enteritidis sporogenes, the results were:—100 per oyster, about 10 per c.c. of oyster, (4%); 10 per oyster, about 1 per c.c. of oyster, (32 %); less than 10 per oyster, *i.e.*, less than 1 per c.c. of oyster, (64 %).

On the other hand, the water of an estuarial river such as the Penryn River, which on topographical grounds has been rightly considered dangerous *qua* oyster layings, but which *qua* bacteriological facts does not abound in microbes of intestinal origin, yielded, as regards B. coli or coli-like microbes, the following results:—100 per c.c. (4 %); 10 per c.c. (44 %); 1 per c.c. (36%); + 10 c.c. (16%). As regards the spores of B. enteritidis sporogenes, 56 % yielded a positive, and 44 % a negative result when using 10 c.c. for cultural purposes. The Penryn water was more than ten times as impure bacteriologically as the Helford water.

Oysters obtained from the Penryn River contained B. coli or coli-like microbes in much greater number than did comparable quantities of the surrounding water: 10,000 per oyster, about 1,000 per c.c. of oyster, (44 %); 1,000 per oyster, about 100 per c.c. of oyster, (52 %); 100 per oyster, about 10 per c.c. of oyster, (4 %). As regards spores of B. enteriditis sporogenes, the results were:—1,000 per oyster, about 100 per c.c. of oyster, (8 %); 100 per oyster, about 10 per c.c. of oyster, (80%); 10 per oyster, about 1 per c.c. of oyster (12 %).

The Penryn oysters were therefore about 100 times more impure than the Helford oysters.

If the worst results from the "good" place (Helford) are to be compared with the best results from the "bad" place (Penryn), assistance from the bacteriologist in determining the *status* of oysters or water, is not to be looked for. On any other basis of comparison the contrast is most striking, and the results, in my opinion, indicate that the *quantitative* and *qualitative* bacteriological testing of oysters and estuarial waters may prove of great practical value in cases of doubtful pollution.

Neither oysters nor water are to be condemned on bacteriological grounds, unless the number of objectionable microbes exceeds what may be termed a "permissible limit of biological impurity." But where the line should be drawn remains to be determined.

In the division of this report dealing with unpolluted sea water, waters (Division III.) and in this division, oysters have been arranged in classes according to the results of the B. coli test.

This does not necessarily involve the acceptance of standards, though it may be convenient to adopt tentatively certain standards *solely for*

Division IV.

Bacteriological Examination of the Helford and Penryn Water and Oysters.

comparative purposes. For example :—To object to (1) a water containing B. coli in 1 c.c., or the spores of B. enteritidis sporogenes in 10 c.c. ; and (2) to reject oysters containing 1000 (lenient standard) or 100 (stringent standard) B. coli ; or 100 (lenient standard) or 10 (stringent standard) spores of B. enteritidis sporogenes respectively per oyster ; *subject always to the examination of a number of samples, and to the interpretation of the results of the B. coli test in the light of a knowledge of the biological attributes of these microbes.*

Applying these tentative standards to the Helford and Penryn results, and ignoring, for the purposes of a broad summary, the modifications of "test-reading" suggested in the text of the report, the following results are obtained :—

WATER.

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. COLI OR COLI-LIKE MICROBES :—				
(negative result, 1 c.c.)	16 %	84 %	68 %	32 %
B. ENTERITIDIS SPOROGENES TEST :—				
(negative result, 10 c.c.)	44 %	56 %	100 %	None.

OYSTERS.

	Penryn.		Helford.	
	Passed.	Condemned.	Passed.	Condemned.
B. COLI OR COLI-LIKE MICROBES :—				
Lenient Standard (less than 1,000 per oyster or 100 per c.c. of oyster)	4 %	96 %	88 %	12 %
Stringent Standard (less than 100 per oyster, or 10 per c.c. of oyster)	None	100 %	24 %	76 %*
B. ENTERITIDIS SPOROGENES TEST :—				
Lenient Standard (less than 100 per oyster, or 10 per c.c. of oyster)	12 %	88 %	96 %	4 %
Stringent Standard (less than 10 per oyster, or 1 per c.c. of oyster)	None	100 %	64 %	36 %

Applying to the oyster question, the principles laid down in the report dealing with unpolluted sea water (Division III.), the following considerations need to be borne in mind.

The contents of the human intestine contain usually millions of B. coli and tens of thousands of spores of B. enteritidis sporogenes per gramme.

Sewage usually contains 100,000 B. coli and 100 to 1,000 spores of B. enteritidis sporogenes per cubic centimetre.

These microbes are absent or, at all events, extremely difficult of detection both in deep sea oysters and sea water.

B. coli, artificially added to unpolluted sea-water and to tap water, speedily loses its vitality or, at all events, was found to become greatly diminished in number under laboratory conditions of experiment. The continued persistence of B. coli *in any number* in estuarial waters is probably due to continuous excremental pollution and to the presence of unoxidised organic pabulum in the water.

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* If the stringent standard were adopted one or other of the modifications of "test-reading" previously suggested would have to be employed. For example :—

	Penryn,		Helford,	
	Passed.	Condemned.	Passed.	Condemned.
Modification No. 1	4%	96%	68%	32%
Modification No. 4	12%	88%	80%	20%

The difficulty is that neither the epidemiologist, nor the topographist, nor even the bacteriologist, can assign a definite "disease value" to a given pollution.

Conclusions as regards the *degree* of potential danger to health arising from sewage pollution must, if sound, be based consciously or unconsciously on knowledge, assumed or real, of the amount of fresh sewage matters present in the water, and more particularly on the number of living microbes of *recent* intestinal outcome.

There appear to be three ways of estimating *degrees of pollution*. The topographical or inferential method* ; the chemical or indirect (*qua* microbes) but broadly useful method† ; and the bacteriological or seemingly most direct method. §

In all but obvious cases of contamination *degrees* of pollution need to be measured by the bacteriologist, who should interpret his results in the light of local observations and epidemiological considerations.

However well-balanced the representations of the topographist as regards estuarial pollution, they are expressions of opinion involving in large measure personal equation, and if uninfluenced by quantitative and qualitative bacteriological data, may be lacking in comparative value, and may therefore be inconclusive.

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[*] In the sense indicated here the topographical method theoretically is mainly speculative in character. But having regard to the breadth of its operations, it may be, and indeed is actually, of *signal and indispensable value in practice.*

[†] The chemical method is a definite and extremely accurate method, and, although indirect in character, may, within certain limits and in certain directions, yield most valuable results.

[§] The bacteriological method is direct *qua* numerical estimation of intestinal microbes, but indirect as regards disease-producing bacteria. Although seemingly the best method, and extremely delicate, it is nevertheless to be thought of as of relative, not absolute, value.

PART V.

ADDENDUM A.

METHOD ADOPTED IN EXAMINING OYSTERS BACTERIOLOGICALLY.

Division IV.
Part V. Add. A.

Method adopted in examining Oysters bacteriologically.

Cleansing of the Oysters :—

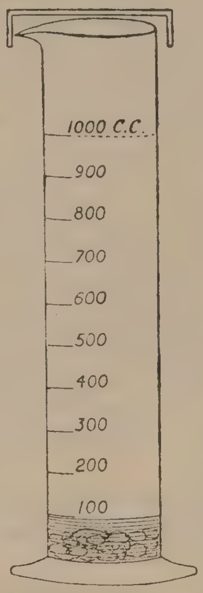
The outside of the oyster shells was well scrubbed with soap and water, and cleansed as thoroughly as possible under clean running water; the shells were then well washed in running *main* water, and finally with sterile water.

Cleansing of the Hands :—

The hands of the experimenter were thoroughly cleansed with a hard scrubbing brush, soap, and water, then rinsed first with 1 in 1,000 corrosive sublimate solution, and finally with sterile water.

Subsequent procedure :—

The oysters were laid out upon a sterile towel, the flat shell uppermost. They were opened in this position with a sterile knife, held in the right hand, while they were held in position with a corner of the sterile cloth grasped in the left hand. Great care was taken to avoid any loss of the liquor in the shell. This liquor was poured into a sterile 1,000 c.c. cylinder, the oyster was then partly cut up with sterile scissors, and the liquor thus freed also allowed to run into the cylinder; finally, the oyster was cut up into small pieces, and added to the cylinder. *Ten oysters were thus treated in each experiment.* The volume of oyster + oyster liquor was *read off*, and usually varied between 80 and 120 c.c., so that the oysters, being of *medium* size and containing a medium amount of liquor, 100 c.c. might be considered a fair average* of the total shell contents of the ten oysters. Sterile water was then poured into the cylinder up to the 1,000 c.c. mark, and the whole well stirred with a sterile rod.



The following amounts of this liquid were taken for cultural purposes (primary cultures) :—

Culture A 100 c.c. = contents of 1 oyster.

,, B 10 c.c. = ,, $\frac{1}{10}$,, multiply by 10. ¶

,, C 1 c.c. = ,, $\frac{1}{100}$,, ,, ,, 100. ¶

,, (1) 1 c.c. of $\frac{1}{10}$ dilution (·1 c.c.) = $\frac{1}{1000}$ oyster, multiply by 1,000. ¶

Culture (2) 1 c.c. of $\frac{1}{100}$ dilution (·01 c.c.) = $\frac{1}{10000}$ oyster, multiply by 10,000. ¶

Culture (3) 1 c.c. of $\frac{1}{1000}$ dilution (·001 c.c.) = $\frac{1}{100000}$ oyster, multiply by 100,000. ¶

Culture (4) 1 c.c. of $\frac{1}{10000}$ dilution (·0001 c.c.) = $\frac{1}{1000000}$ oyster, multiply by 1,000,000. ¶

¶ To obtain the number of bacteria, *e.g.* B. coli, per oyster. (*Divide the figures thus obtained by 10, if the results per c.c. of* **oysters** *are wanted.*)

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* This average has been used generally as a convenient basis for calculating the relation between the number of bacteria per c.c. in the oyster and the water over the oyster layings. It is, however, an under-estimate of the bulk of many oysters. It must be remembered that the bacteria are not uniformly distributed within the contents of the oyster shell. No doubt the liquor, alimentary tract and perhaps the gills harbour most of the microbes, and the tissue of the body of the oyster may be, relatively speaking, sterile.

Division IV., Part V. Add. A.

Method adopted in examining Oysters bacteriologically.

These amounts, A, B, C, 1, 2, 3, 4, were used for the examination for B. coli (primary cultures)*, and the amounts B, C, 1, 2, 3, for the B. enteritidis sporogenes test. Experience has shewn that it is best to make the primary cultures in triplicate. Then if, as regards the B. coli test, a sugar medium is employed, at least two out of the three primary cultures should form acid and gas to allow of a *preliminary numerical* diagnosis being made.

Similarly, in respect of the B. enteritidis sporogenes test, the "enteritidis" change should occur in at least two out of the three anaerobic milk cultures to merit a positive result being recorded.

The subsequent procedure, so far as the B. coli test was concerned, was the isolation of B. coli or coli-like microbes from the primary cultures, by means of secondary gelatine plate cultures, followed by study of the isolated microbe in the *pure state* in the following media :—

Gelatine "shake" cultures (for "gas" formation); † Broth cultures (for indol formation); Litmus milk cultures (for acid and clotting); Lactose peptone cultures (for acid and gas); Neutral-red broth cultures (for greenish-yellow fluorescence).

Speaking in general terms, two colonies of B. coli were selected for subculture and study, and these were taken respectively from the last and last-but-one dilutions yielding coli-like microbes in the secondary plate cultures from the corresponding primary cultures.

As regards B. enteritidis sporogenes, the inoculation of animals was not practised, so that the results must be interpreted in the sense that a positive result means the "enteritidis change" in anaerobic milk culture without proof of virulence.

Example :—10 oysters were cleaned, opened, cut up, and transferred to a 1,000 c.c. sterile cylinder. The shell contents of the 10 oysters were found to reach the 100 c.c. mark on the cylinder. Sterile water was poured in up to the 1,000 c.c. mark. After stirring with a sterile glass rod, primary cultures A, B, C, 1, 2, 3, 4, were made as above indicated. The final result as regards B. coli was that typical B. coli was isolated from the secondary gelatine plate culture, corresponding to the No. 2 primary culture. The 2 primary culture represented $\frac{1}{100000}$ part of the total contents of the cylinder. As 10 oysters were used, this means $\frac{1}{10000}$ part of 1 oyster contained B. coli, or 10,000 B. coli were present *per oyster*. Further, as each oyster measured 10 c.c., the result was 1,000 B. coli *per c.c.* of oyster. As regards the B. enteriditis sporogenes test cultures, B and C gave a positive result; 1, 2 and 3 yielded negative results. Hence there were 100 spores of B. enteritidis sporogenes per oyster, or 10 spores per c.c. of oyster.

This method was first tried in connection with the examination of a sample of oysters obtained from Burnham on March 31st 1903.

The chief advantages of this method are as follows :—

1. It is a *definite quantitative* method, succeeded by qualitative records.
2. It gives the average volume of the whole contents of the oyster shell.
3. It yields results based on collective examination of ten oysters.
4. It includes the examination of the entire contents of the shell, not of a fraction either of the liquor or the gastric or intestinal juice, or of the mixture of these liquids.
5. The results can be stated as number of bacteria, either per oyster, or per c.c. of oyster.

An alternative quantitative method for the bacteriological examination of oysters.

An alternative method for the bacteriological examination of oysters may be given here, although the routine work, except where otherwise stated, has been carried out by the foregoing method.

The oysters are cleaned and opened, with the precautions already noted. Then the body of the oyster is cut into small pieces with sterile scissors; this process should be carried out in such a way as to ensure the thorough mixture of the gastric juice of the oyster and the liquor. The oyster, meanwhile, is carefully held with the concave shell downwards and the flat shell bent back or altogether removed. To examine the liquid contents of the shell with-

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* As regards the primary culture, either ordinary broth or phenol broth, or neutral-red broth or sugar broth may be used. But the bile-salt-glucose-peptone medium of Mac Conkey has many practical advantages.

† By this stage, the number of gas-forming coli-like microbes present in the sample has been ascertained. It remains to determine how far the coli-like microbe isolated resembles in its biological attributes *typical* B. coli.

Method adopted in examining Oysters bacteriologically.

out this preliminary step may partake of the nature of the examination of the last sample of sea water imbibed by the oyster before finally closing its shell. Indeed, the experiments detailed elsewhere seem to indicate that *per unit of volume* the gastric juice of the oyster may be more impure bacteriologically than the oyster liquor.

The next step is to withdraw 1 c.c. of the oyster mixture with a sterilised 1 c.c. pipette and add it to 9 c.c. of sterile water in a test tube (dilution 1). 1 c.c. of dilution (1) is used to inoculate a second tube containing 9 c.c. of sterile water (dilution 2). 1 c.c. of dilution (2) is used to inoculate a third tube containing 9 c.c. of sterile water (dilution 3), and so on to further dilutions if necessary. Primary cultures, using in each instance 1 c.c., are next made severally from dilutions (1) (2) (3), corresponding to $\frac{1}{10}$, $\frac{1}{100}$, and $\frac{1}{1000}$ c.c., respectively, of the oyster mixture.

Further, 1 c.c. of the oyster mixture direct, that is without any dilution is used to make another primary culture. From these primary cultures, after incubation for two days at 37° C., secondary plate cultures are made, and from these plates the coli-like colonies are subsequently picked out and studied in pure culture in various media.

The above procedure applies to the B. coli test, but it is obvious that the same dilutions might also be employed for the B. enteritidis sporogenes test.

The above method answers fairly well if the oysters contain a sufficient volume of liquor, and if conclusions are based on the examination of at least 10 oysters. Nevertheless, this method is not free from certain objections. The volume of liquor in oysters varies enormously, ranging from as little as 0·1 c.c. to over 10 c.c., and the results might naturally vary in corresponding degree. Sometimes the amount of liquor is too small to allow more than one culture being made, even if that end be achieved, at other times it is so large as to suggest that sea water is diluting the bacterial contents of the oyster itself to a considerable extent. At all events, it is obvious that if the liquid contents of the shell may vary one hundred times, it is difficult to ensure that comparative quantitative records are always obtained.

Division IV.
Part V., Add. B.

Streptococci and other Microbes in Oysters.

ADDENDUM B.

ISOLATED EXPERIMENTS BEARING ON THE PRESENCE OF STREPTOCOCCI AND OF OTHER MICROBES EITHER IN THE PENRYN OR HELFORD OYSTERS.

Streptococci.

Unfortunately the pressure of other work rendered adequate investigation in this direction impossible. But from a loopful of the stomach juice of a Penryn oyster (September 27th), and 0·01 c.c. of the stomach juice of another Penryn oyster (September 30th) two streptococci (1 and 2) respectively were isolated. Their morphological and biological characters were as follows :-

	Streptococcus 1.*	*Streptococcus* 2.
Morphology - - -	Short to medium chains.	Very short chains.
Broth cultures - - -	Diffuse and granular cloudiness.	Diffuse cloudiness.
Litmus milk cultures - -	Bleached appearance, no clot.	Bleached appearance, no clot.
Gelatine streak cultures - -	Minute transparent-looking colonies.	Minute transparent-looking colonies.
Neutral-red broth *anærobic* cultures (suggested by Dr. Gordon).	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.

Attempts to isolate streptococci from the Helford oysters were unsuccessful. This was perchance due to the relative absence of streptococci or an insufficient number of experiments.

Vibrio (*see* micro-photograph 2).

On October 6th 1903, a vibrio was isolated from 0·01 c.c. of the stomach juice of a Helford oyster. The following is a brief description of its chief morphological and biological characters :—

	Vibrio.†
Morphology - - - -	Actively motile, stains with difficulty.
Cholera-red reaction - - -	Negative.
Litmus milk cultures - - -	Appearance as of slow peptonisation with blue ring at surface of liquid.
Gelatine streak cultures - -	Small non-liquefying, somewhat transparent-looking colonies.
Broth cultures - - - -	Diffuse, but not very abundant cloudiness.
Pathogenesis - - - -	Non-pathogenic (rodents).

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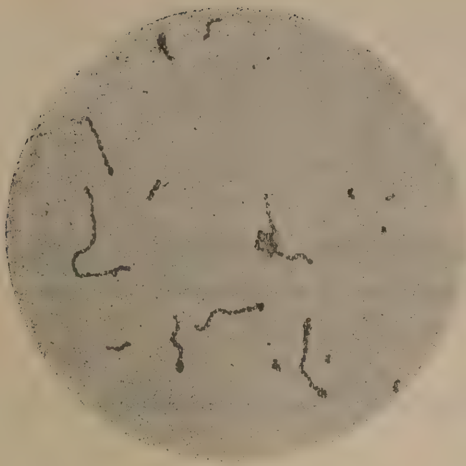
* See micro-photograph 1.
† See micro-photograph 2.

Division IV.
Part V. Add. B.

Streptococci and other Microbes in Oysters.



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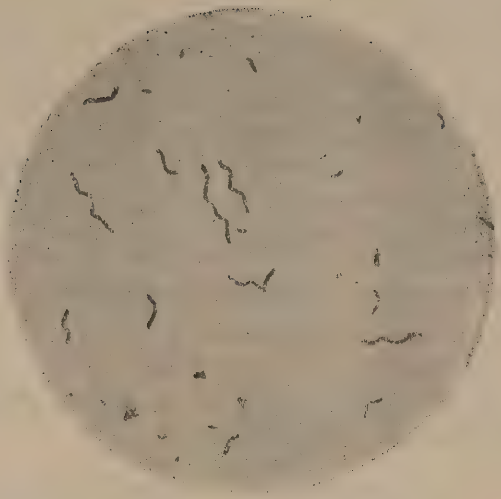

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B. pyocyaneus.

On September 23rd 1903, the stomach juice of ten Penryn oysters was mixed together. From $\frac{1}{10}$ c.c. of this mixture a microbe indistinguishable from B. pyocyaneus was isolated. A guinea-pig inoculated with 1 c.c. of a broth culture of this microbe died within 48 hours. B. pyocyaneus was isolated in pure culture from the heart's blood of the animal.

On October 6th 1903, a microbe *seemingly* indistinguishable from B. pyocyaneus was isolated from ·01 c.c. of the stomach juice of a Helford oyster. Nevertheless, a guinea-pig inoculated with 1 c.c. of a broth culture of this microbe did not die, but showed only a local reaction at the site of inoculation.

MICRO-PHOTOGRAPH 1.

Microscopic preparation from a culture of streptococcus 1; isolated from the stomach juice of a Penryn oyster.

(Magnifying power, 1,000.)

MICRO-PHOTOGRAPH 2.

Microscopic preparation from a culture of a vibrio isolated from ·01 c.c. of the stomach juice of a Helford oyster

(Magnifying power, 1,000.)

Division IV.
Part V. Add. C.

Porthcuel and Helford waters and Oysters.

ADDENDUM C.

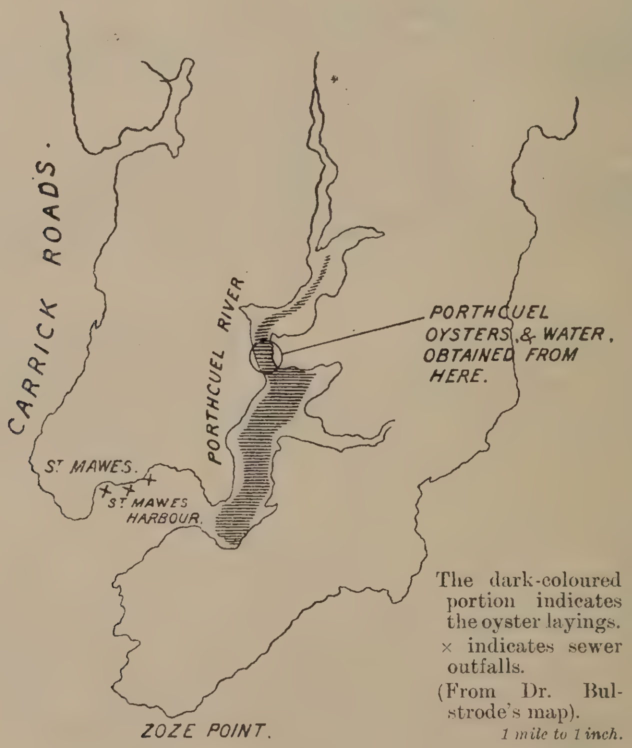
Results of the Bacteriological Examination of Samples of Water and Oysters obtained from the (I.) Porthcuel River and (II.) Helford River at Pond Creek.

I. The oyster layings in St. Mawes Creek (Porthcuel River) are described by Dr. Bulstrode* as follows :—

> "St. Mawes Creek is situated to the east of the Carrick Roads, and extends inland from the village of St. Mawes for a considerable distance. In St. Mawes Harbour itself, which is situated immediately opposite the village of that name, there are no oysters laid down ; but eastward of Amsterdam Point, to the south, they extend up both sides of the Porthcuel River to the commencement of Polingey Creek . . . . a distance in all about two miles. There are along this river certain areas where oysters are not laid down, as, for instance, at mooring stations and at ferries. The oysters taken from these layings are, I am informed, sent direct to market, inasmuch as in this creek they rapidly lose the green colouration which they possess when freshly dredged up from the roads ; they are packed up on board the boats or in neighbouring hamlets, and despatched by steamer to Falmouth."

As regards the liability of the oyster layings to sewage pollution, Dr. Bulstrode, on page 58, says :—

> "At St. Mawes the drainage of the village is discharged by various openings on to the foreshore."



The dark-coloured portion indicates the oyster layings.
× indicates sewer outfalls.
(From Dr. Bulstrode's map).
1 mile to 1 inch.

Again, lower down on the same page Dr. Bulstrode remarks :—

> "With reference to St. Mawes Creek, it has to be observed that the oyster layings are situated at a point above, and rather over half-a-mile from the Village, and are, indeed separated from it by the whole width of St. Mawes Harbour. The amount of dilution which must take place before any sewage can cross the river is so great as to render the layings in this Creek and River but little liable to pollution."

---

* Oyster Culture in Relation to Disease. Report of the Medical Officer, Local Government Board. 1894-5.

Division IV. Part V., Add C.

Porthcuel and Helford Waters and Oysters.

On August 19th, Dr. Charles was kind enough to take me in his sailing boat some distance up the Porthcuel River, and the locality seemed in every way suitable for oyster layings. Moreover, a sample of water (No. 14, Table 4) collected on that date yielded the most satisfactory results, inasmuch as no coli-like microbes of any sort were present in 100 c.c., and no spores of B. enteritidis sporogenes in 10 c.c. of the sample. Under these circumstances, it was considered desirable to examine both oysters and water from the Porthcuel layings. The result as regards the water are shewn in the following table :—

Division IV.
Part V.
Add. C.

Porthcuel and Helford Waters and Oysters.

TABLE 7, showing the results of the Bacteriological Examination

1						2							
DESCRIPTION OF THE SAMPLE.						Number of B. Coli, or gas forming coli-like microbes in 1 c.c.							
No.	Time of Collection.				Other Details.	+ 100 c.c.	+ 10 c.c.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month	Year.				1 c.c.	·1 c.c.	.01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
I. P	High	31	8	1903	Porthcuel River water, 50 yds. off beach	+	−						
II. P	High	31	8	,,	Porthcuel River water, 6 ft. reach above Porthcuel	−							
A	Low	5	9	,,	Porthcuel River water -			+	−				
									Characters of the coli from the 10 c.c. culture.				
2	High	10	9	,,	Porthcuel River water -	+	−						
3	Low	16	9	,,	Porthcuel River water -		+	−					
									Characters of the coli from the 100 c.c. culture.				
4	High	23	9	,,	Porthcuel River water -			+	−				
									Characters of the coli from the 10 c.c. culture.				
B	½ tide flood	30	9	,,	Porthcuel River water -		+	−					
									Characters of the coli from the 10 c.c. culture.				
C	Low	7	10	,,	Porthcuel River water -			+	−				
									Characters of the coli from the 10 c.c. culture.				
1	Low	23	9	,,	Helford River water, from Pond Creek; water 5 feet deep			+	−				
									Characters of the coli from the 10 c.c. culture.				
2	High	30	9	,,	Helford River (Pond Creek) taken opposite the oyster beds, along the shore			+	+				
									Characters of the coli from the 10 c.c. culture.				

of the Porthcuel, and Helford River (Pond Creek) Waters.

3						4						5
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Spores of B. enteritidus sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						
Gas (Gelatine "shake" cultures, 24 hrs. at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot- (Litmus milk cultures, 5 days at 37° C.)		Lactose-peptone Medium, + = acid and gas, 48 hours at 37° C.	Neutral Red (Broth cultures, + = greenish-yellow fluorescence, 48 hours at 37° C.)	1	10	100	1,000	10,000	100,000	REMARKS.
		(a)	(b)			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+ N.L.	+	+	+	+	+			Negative 10 c.c.				Nos. 2, 3, 4, of water samples, correspond to oyster samples Nos. II., III., IV.
								Negative 10 c.c.				
+ N.L.	–	+	–	–	–			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	–	+	+			Negative 10 c.c.				
+ N.L.	+	+	–	+	+							
+ N.L.	–	+	–	–	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				Water sample Nos. 1 and 2 correspond with, oyster samples Nos. I. and II.
+ N.L.	–	+	–	–	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							

N.L. signifies that no liquefaction of the gelatine occurred within one month.

Division IV.
Part V. Add C.

Porthcuel and
Helford Waters
and Oysters.

On August 31st, Dr. Charles was kind enough to collect personally two samples of water (I. P. and II. P. Table 7) and to make arrangements for the subsequent collection of water (A. 2, 3, 4, B, C, Table 7) and of oysters (I., II., III., IV. Table 8).*

As regards water samples I. P and II. P the results were satisfactory, inasmuch as neither sample contained any spores of B. enteritides sporogenes in 10 c.c., nor B. coli in 10 c.c. But sample I. P contained B. coli in 100 c.c.

Unfortunately the later samples of water yielded less satisfactory results. As regards the B. coli test, one sample contained B. coli in 100 c.c., two samples B. coli or coli-like microbes in 10 c.c., and three samples in 1 c.c. It follows that one-half of the samples were condemned on the standard tentatively suggested of a negative result with 1 c.c. of the sample. None of the samples, however, were open to objection in respect of the B. enteritidis sporogenes test, since in each case the spores of this anaerobe were absent from 10 c.c. of the samples. The precise locality whence these samples were obtained was not personally inspected by the writer, but Dr. Charles states that the local conditions are eminently favourable. It would seem as if in shallow water contiguous to land, even in regions seemingly remote from sewage pollution, a few B. coli or coli-like microbes may be present. But the difficulty arises, that if the suggested standards be relaxed, then certain other and probably deeper waters, less near the land, might escape condemnation, although open perhaps to suspicion of objectionable pollution from the topographical point of view. It will be noted that here, as elsewhere, in the report, no attempt is made to impugn a locality in order to accord with the ascertained bacteriological facts.

In the following table (Table 8) the results are shewn of the bacteriological examination of the Porthcuel and Helford (Pond Creek) oysters :—

---

* See also Map 4 and foregoing Sketch Map.

TABLE 8.

SHOWING the Results of the Bacteriological Examination of the Porthcuel and Helford (Pond Creek) Oysters.

Division IV.
Part V.
Add. C.

Porthcuel
and **Helford**
Waters and
Oysters.

TABLE 8, showing the Results of the Bacteriological

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. coli (gas-forming coli-like microbes), per oyster (average of 10 oysters).					
No.	Time of Collection. Tide.	Day.	Month.	Year.	Other Details.	1	10	100	1,000	10,000	100,000
I.	–	31	8	1903.	Porthcuel River oysters - -				+	–	
						Characters of coli from lower dilutions					
II.	High	10	9	,,	,, ,, - -			+	–		
						Characters of coli from lower dilutions					
III.	Low	16	9	,,	,, ,, -		+	–			
						Characters of coli from lower dilutions					
IV.	High	23	9	,,	,, ,, - -			+	–		
						Characters of coli from lower dilutions					
I.	Low	23	9	,,	Helford River oysters from Kitto layings at Pond Creek.			+	–		
						Characters of coli from lower dilutions					
II.	High	30	9	,,	Helford River oysters from Kitto layings at Pond Creek.			+	–		
						Characters of coli from lower dilutions					

xamination of Porthcuel and Helford (Pond Creek) Oysters.

3. Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.						4. B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures) per oyster (average of 10 oysters). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium. + = acid and gas 48 hours at 37° C.	Neutral red broth cultures. + = greenish yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(a)	(b)									
+ N.L.	—	+	—	+	+	Less than 10 per oyster.						Nos. II., III., IV., of oyster samples, correspond with Nos. 2, 3 and 4 of Porthcuel water samples.
+ N.L.	—	+	—	+	+							
+ N.L.	—	+	+	—	—	Less than 10 per oyster.						
+ N.L.	—	+	+	+	+							As regards the bulk of the oysters :— Sample I., 10 oysters measured 145 c.c. Sample II., 10 oysters measured 150 c.c. Sample III., 10 oysters measured 120 c.c. Sample IV., 10 oysters measured 130 c.c.
+ N.L.	+	+	—	+	+	Less than 10 per oyster.						
+ N.L.	+	+	+	—	+							
+ N.L.	—	+	+	+	+	Less than 10 per oyster.						
+ N.L.	+	+	+	+	+							
+ N.L.	—	+	—	+	+	Less than 10 per oyster.						Nos. I. and II. of oyster samples correspond with No. 1 and 2 Helford water samples.
+ N.L.	+	+	+	+	+							
+ N.L.	—	+	—	—	—	Less than 10 per oyster.						As regards the bulk of the oysters :— Sample I, 10 oysters measured 140 c.c. Sample II, 10 oysters measured 110 c.c.
+ N.L.	+	+	+	+	+							

N.L. signifies that no liquefaction of the gelatine occurred within one month.

Porthcuel and Helford Waters and Oysters.

It will be noted that coli-like microbes were comparatively abundant in the Porthcuel oysters. One sample of oysters contained 1,000, two samples 100, and one sample 10 coli-like microbes per oyster. According to the lenient standard provisionally suggested (less than 1,000 per oyster), one out of the four samples would be condemned.

As regards the B. enteritidis sporogenes test, none of the samples were open to objection, since in each case there were at all events less than 10 spores of this anaerobe per oyster.

Certain additional experiments with the Porthcuel oysters are dealt with in App. G. and I., Division V.

II.—THE OYSTER LAYINGS IN THE HELFORD RIVER AT POND CREEK.

The Porth Navas oyster layings (Helford River) having yielded results not wholly in keeping with the topographical features of the locality, it was determined to examine the water and oysters in Pond Creek (*see* map 1 and sketch maps in text of Part I., Division IV.).

It has already been noted that this place (Pond Creek) was visited on April 25 1903, and that a sample of water (No. 47) collected over the oyster layings yielded negative results with 10 c.c. both as regards the B. coli and B. enteritidis sporogenes tests. It was hoped, therefore, that similar results would always be obtained. Such, unfortunately, was not found to be the case, as will be seen by referring to the foregoing Tables 7 and 8.

In the first place as regards the water, it was found that, although neither of the samples contained any spores of B. enteritidis sporogenes in 10 c.c. B. coli was present in 1 c.c. of both samples. Hence the water appeared to be no purer, bacteriologically, if as pure, as the water in the region of Porth Navas Creek.

Secondly, as regards the oysters, coli-like microbes were present in the proportion of 100 per oyster, and typical B. coli to the extent of 10 per oyster. Neither of the samples, it is true, would have been condemned according to the suggested lenient standard (less than 1,000 per oyster), but on topographical grounds the almost total absence of B. coli might have been anticipated. The B. enteritidis sporogenes results were satisfactory, as both samples contained at all events less than 10 spores per oyster.

There seemed to be no great advantage in continuing these observations, under pressure of other work, as neither the oysters nor the water differed biologically to any conspicuous extent from those obtained from Porth Navas Creek.

In conclusion, and speaking both of the oysters and the water obtained from the Porthcuel River, and the Helford River at Pond Creek, it must be admitted that the bacteriological results were not always in keeping with the topographical features of these localities.

Division IV.
Part V., Add. D.

Float Experiments.

ADDENDUM D.

FLOAT EXPERIMENTS.

During the second visit to Falmouth some float experiments were made, but owing to the unsatisfactory state of the weather and other causes, they were not very successful.

Dr. Charles, however, very kindly promised to continue them under more suitable conditions. The following is his instructive account (*see* accompanying sketch map), of experiments carried out on September 8th, 15th, and 16th, 1903.*

On observations made upon September 8th 1903, *regarding the influence of the tides on objects floating near the surface in Falmouth inner harbour* :—

At six o'clock at high water Mr. Rees went up to Boyer's cellars and threw six loaded† ping-pong balls and 12 loaded bottles with painted necks into mid-stream.

A light breeze from the west-north-west was blowing, which, however, did not affect either bottles or balls much.

The bottles being well sunk in the water, with nothing but their necks exposed, were distinctly less affected than the balls.

The balls and three bottles ran up against Flushing Quay, at about half-past eight. These were taken on board and carried out again into the stream, where the other bottles were, about one-third out in the stream towards Greenbank.

About nine o'clock, two of the bottles stranded at Newquay. These were kept in the boat. The others at that time were in a strong tide, and being carried rapidly down among the yachts. Here they created great excitement among the gulls, who were very useful in marking the position of the different objects floating down. By this time the wind was increased much, and had backed nearly to the west.

Eight bottles stranded between a reef which runs out from Dr. Gover's house and Kiln Quay, along with two balls.

Two of the bottles went down to Trefusis Point, and it was noticed that these were more heavily weighted than the others, being sunk so as to show less than an inch of neck.

Two of the bottles stranded in the bight, just before Trefusis Point. This brings us down to 12 o'clock. The tide turned ten minutes after.

Two of the bottles, which went furthest, were caught in the dense weeds about 40 yards from the shore. As the tide rose these were carried up again, and floated in the direction of the docks.

They then changed their direction and became stranded below Dr. Gover's house, having gone higher up the harbour, but being carried down by the eddy which ran down inshore.

These two bottles were now taken on board. By this time a strong wind was blowing from the west, and an attempt was made to float some more ping-pong balls. They were, however, thrown out of the water by the waves, and as the bottles had to be watched the balls were recovered and taken into the boat.

For two hours after low tide the bottles made very little progress, having moved less than 100 yards. When they began to move, they got in under the lee of yachts, and made no progress, and an hour before high water were picked up still near Dr. Gover's house. The weather by this time was very rough; sometimes half a gale of wind was blowing, so that it was very difficult to manage the rowing boat.

---

* Dr. Charles, with the knowledge gained by these preliminary observations, was anxious to carry out further float experiments. This would have been of great advantage, but the necessity of furnishing the Commission with this report at an early date has precluded the acceptance of his kind offer to continue the observations.

† The balls were filled with fresh water by means of a hypodermic syringe.

In conclusion, all the six ping-pong balls and 12 bottles were recovered, none of them having gone beyond Trefusis Point.

On observations made upon the 15*th and* 16*th of September* 1903, *regarding the influence of the tides, on objects floating about* 5 *feet below the surface, in Falmouth inner and outer harbours.*

It may here be noted, that the previous report was written regarding an experiment made during the highest spring tide of the fortnight, and dealt with the surface of the tide.

The present experiment was undertaken, during the slackest neap tide of the fortnight, and the one which preceded it by 24 hours. The report deals with the effect of the tide at 5 feet, or rather more, below the surface.

An attempt was made to combine the study of the superficial with the deep currents, as the experiment was begun in a dead calm. Almost immediately, however, a most gentle breeze sprang up, and the ping pong balls were floated up against the tide, or rather against the dead water, and became so far separated from the loaded bottles floating 5 feet below the surface, that they had to be left to their fate, so that the bottles might be watched. It may here be mentioned that the bottles cannot be left even for a few minutes, as attempts were made to pick them up as they neared the shore, to use them for household purposes. Also from mere curiosity, visitors rowing about tried to raise them out of the water, and had to be requested to put them back again. Excursion steamers, tugs and motor launches, have not only broken the bottles, but interfered somewhat in other ways with the experiment. Sailing ships and ships at anchor have also proved more or less obstructive, but on the whole the results have been satisfactory.

A dozen bottles were thrown overboard between Flushing Quay and Greenbank exactly at high tide at Falmouth, as stated in the almanack. Some three of them having been too heavily weighted, sunk, and were not found again. For more than an hour the tendency of the bottles was either to remain still, or float upwards towards Penryn.

More than one of the bottles finally drifted down close to Flushing Pier, and had to be carried out again a short distance, so as to get them back into the outgoing tide.

Five of them then went slowly down the harbour till, at 5.30, low water they stopped half-way between Kiln Quay and the western breakwater shortly after the tide turned, they began to float upwards, assuming a direction slightly towards Falmouth. At 7.30, it became too dark, so five of them were recovered in the middle of the harbour and brought back to Flushing. A sixth bottle had been caught on the mooring chain of a vessel, and an hour after the tide turned was picked up by a visitor near Greenbank.

The observations made on September 16th, during the lowest neap tide of the fortnight, were begun by throwing the bottles into the outer harbour half-way between the Governor Buoy and Pendennis Castle, at 6 a.m., when it was low water at Falmouth. They floated up the Carrick roads, with an inclination towards Falmouth, and approached close to the centre of the eastern breakwater. As here there is a stone embankment to strengthen the foundations of the breakwater, the swell rendered it dangerous for the bottles to be left in this position; they were therefore carried out at some distance from the breakwater and thrown overboard in a line with the Governor Buoy. They then all floated up the inner harbour and at 12 o'clock, high water, they had reached a point off the hothouse at Dr. Gover's which is locally known as Clay Point, about 200 yards from the shore.

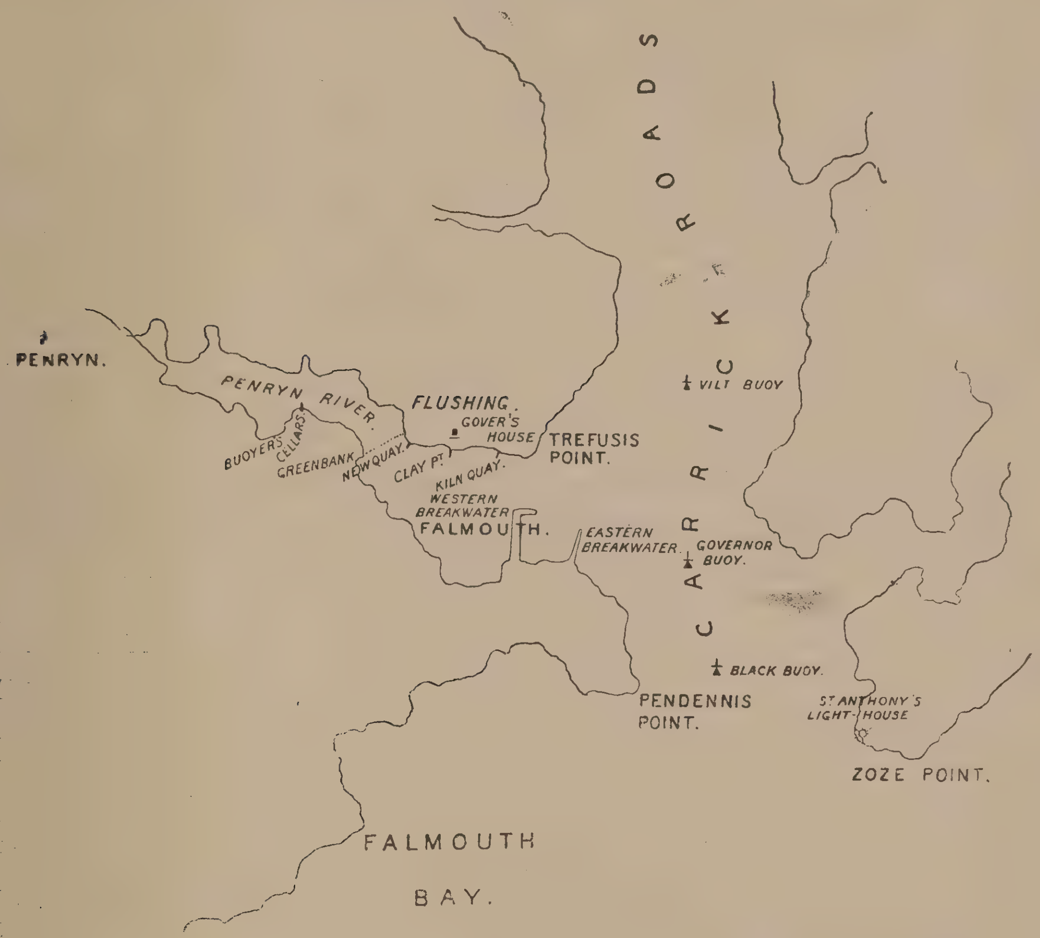
Division IV.
Part V.,
Add. D.

Float Experiments.

When the tide turned, they floated back again into the Carrick Roads, and at 6.20, low water, they were reclaimed at a point more or less half-way between the Velt Buoy and the Black Rock. The experiment had to be stopped at this hour, owing to the exhaustion of the man in the boat, who had been watching them for 12 hours. His instructions were, not to withdraw the bottles till it was seen whether they were caught in the tide running up towards Truro River, or should they have come back towards the inner harbour, not till it became too dark to watch them.

Mr. Rees states, that they had been carried so far out, that from the local experience regarding the effect of the tides, he considered that it was quite impossible that the bottles should have ever floated in again into the inner harbour; and he considers it as quite certain, that the incoming tide would have carried them up, more or less in the direction of the Truro River.

The day for this experiment was an ideal one; towards evening a slight wind from the south was blowing, but not enough to interfere much with the boat from which the bottles were watched.



SCALE OF ONE MILE TO ONE INCH.

DIVISION V.

APPENDICES A to L.

Results of a number of separate bacteriological observations bearing on the general question of the pollution of estuarial waters and shell-fish.

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APPENDIX A.

Results of the Bacteriological Examination of samples of Sea Water, Estuarial Water, water over shell-fish layings, etc. Collected for the most part during the visits paid by the Commission to various centres of the Oyster Industry.

Division V.
Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

TABLE showing the Results of the Bacteriological Examination of numerou

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas forming coli-like microbes) in 1 c.c.						
No.	Time of Collection.				Other Details.	+ 10 c.c.	1	10	100	1,000	10,000	100,0
	Hour.	Day.	Month.	Year.			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·0000 c.c.
					SECTION I.							
					Langston, Emsworth, and Chichester Channels; Solent sea water; North Saltern and Gutner Creeks; Emsworth and Bosham oyster pits. (*Map No.* 1B).							
2		15	3	1903.	*Langston Channel*, flood tide, near full tide, about 30 yards out from Ferry.	+	–					
3		15	3	"	*Solent* water opposite Grand Hotel, beach sample, about low tide.	+	–					
4		16	3	"	*North Saltern Creek*, near mouth of Emsworth Channel ebbing tide.	+	–					
5		17	3	"	*Gutner Creek* oyster pond, filled to the top last high tide, east of sloop. Creek off Emsworth Channel. Represents purest condition of water.	–						
6		17	3	"	*Langston Channel*, flowing tide, near high tide, near Hayling oyster fishery and station.		+	–				
7		18	3	"	*Emsworth* Longshore oyster pit, Kennet.		+	–				
8		18	3	"	*Emsworth* Longshore oyster pit, Foster.			+	–			
9		18	3	"	*Emsworth Channel*, 7 yards below sewer outfall, tide half flood, flap seemingly closed.				+	–		
10		18	3	"	*Bosham* oyster pit.		–					
11		18	3	"	*Chichester Channel*, Del Quay, about high water, 1 mile below Chichester sewage outfall, taken from boat.		+	–				
A	3·55p.m.	10	4	"	*Langston Channel*, midstream, flood tide (at Ferry).	+	–					
B	3.5 p.m.	10	4	"	*Solent*, midway between Ryde and Southsea Piers, at half ebb tide.	–						
					SECTION II.							
					Shoreham and Southwick Channels, and Southwick oyster ponds. (Map Nos. 2 and 3A.)							
12		19	3	"	*Shoreham Channel*, just above Norfolk Bridge, 300 yards below sewer outfall, west side, tide on the turn, beginning to flow.				+	–		

ples of Sea Water, Estuarial Water, and Water from Oyster Pits, etc.

Division V.

Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

3. Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				4. B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.					
Gas. Gelatine shake" cultures, 24 hours , 20° C.).	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days, at 37° C.).		1	10	100	1,000	10,000	100,000
		(a)	(b)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
+	+	+	+	–		(Positive 10 c.c.)			
+	–	+	–			Negative 10 c.c.			
+	+	+	+	+	–				
						Negative 10 c.c.			
+	+	+		+	–				
+	+	+	+			Negative 10 c.c.			
+	+	+	+	–		(Positive 10 c.c.)			
+	+	+	+	+	–				
				–		(Positive 10 c.c.)			
+	+	+	+	–		(Positive 10 c.c.)			
+	+	+	+	–		(Positive 10 c.c.)			
				–		(? Positive 10 c.c.)			
+	+	+	+	+	–				

Division V.

Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

TABLE showing the Results of the Bacteriological Examination of numerou

1.						2.						
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.						
No.	Time of Collection.				Other Details.	+ 10 c.c.	1	10	100	1,000	10,000	100,00
	Hour.	Day.	Month.	Year.			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
13		19	3	1903	*Southwick* Brazier's oyster pond. Low water.		+	–				
14		19	3	„	*Southwick Channel*, quarter flood, opposite Brazier's ponds.			+	–			
15		19	3	„	Same as No. 13, but from another pond.		–					
					SECTION III.							
					Crouch and Roach Rivers, Burnham effluents and Roach storage pit (Map No. 4.).							
7		31	3	„	*Burnham*, 1 to 2 hours flood, Crouch Channel, 1 mile above Burnham, Mid-Channel, boat sample.	–						
18		31	3	„	*Burnham*, fine bed effluent from No. 2 bed, one-third empty.					+	–	
19		31	3	„	*Burnham*, outfall of Burnham effluent (combined effluent) into Creek leading to Crouch Channel.							+
20		31	3	„	*Pilehouse Gutter Greek*, land drainage water. Said to contain no salt water. (*Burnham*.)			+	–			
21		31	3	„	Mixed *Burnham* effluent and sea water above sluice, opening into Crouch Channel.							+
22		31	3	„	Fattening beds mouth of *Crouch*, about ½ flood, boat sample.	—						
23		31	3	„	*Crouch, at Holliwell*, North Shore, near junction of Roach, 3 parts flood. Boat sample.	+	–					
24		31	3	„	*Roach*, at White House, high water, fattening beds. Boat sample.	+	–					
25		31	3	„	At top of *Roach* fishery, tide ⅛ ebb. Barling Creek, boat sample.	–						
26		31	3	„	Oyster storage pit, *Roach*, mature oysters. Poole Creek pits.	–						
					SECTION IV.							
					Brightlingsea Creek, tank effluent, Colne and Pyefleet Channels Pyefleet storage pit. (Map No. 5.)							
27		1	4	„	*Brightlingsea Creek.*—Over private layings, boat sample, 2 hours flood.		+	–				
31		1	4	„	Tank effluent, Ives' Patent, *Brightlingsea.*							+

mples of Sea Water, Estuarial Water, and Water from Oyster Pits, etc.—*continued.*

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Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

3. Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				4 B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80°C. for 10 minutes.					
Gas. (Gelatine "shake" cultures, 24 hrs. at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
+	+	+	+			Negative 10 c.c.			
+	+	+	–	+	–				
						Negative 10 c.c.			
				+	–				
+	+	+	+	+	–				
+	+	+	+				+		
+	+	+	+	–		(? Positive 10 c.c.)			
+	–	+	–		+	–			
				–		(Positive 10 c.c.)			
+	+	+	+	+	–				
+	–	+	+			Negative 10 c.c.			
				+	–				
				–		(Positive 10 c.c.)			
+	+	+	–	+	–				
+	+	+	+			+	–		

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Appendix A.
Bacteriological Examination of isolated samples of Sea Water.

TABLE showing the Results of the Bactereological Examination of numerou

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.						
No.	Time of Collection.				Other Details.	+	1	10	100	1,000	10,000	100,00
	Hour.	Day.	Month.	Year.		10 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
28		1	4	1903	*Colne Channel*, extreme point of fishery, 2–3 hours flood, boat sample.		+	–				
29		1	4	,,	*Pyefleet Channel*, opposite packing house, from boat, ⅔ flood tide.	+	–					
30		1	4	,,	Pit 23, *Pyefleet* pit, near packing house.	+	–					
35		1	4	,,	*Pyefleet Channel* (head of) Pyefleet side of road separating Strood and Pyefleet Channels, nearly high tide.	+	–					
					SECTION V. *Blackwater and West Mersea oyster ponds.* (Map No. 5).							
32		2	4	,,	*Blackwater Strood Channel* Mr. Bean's Victory layings, taken from boat ¼ flood tide opposite Inn.	–						
33		2	4	,,	Ditto about 100 yards higher up Channel.	–						
34		2	4	,,	From Mr. Bean's oyster pits, *West Mersea*.	+	–					
34a		2	4	,,	Same as 34, but mud stirred up.	+	–					
					SECTION VI. *Teign River.* (Map No. 3B.)							
51		27	4	,,	*Teign River* under Shaldon Bridge, midstream ⅔ flood tide.	+	–					
52		27	4	,,	*Teign River*, about 2 miles above Shaldon Bridge by Combe Cellars, boat sample over cockles, tide ⅔ flood, this is a well-known place for cockle teas.				+	–		
53		27	4	,,	*Teign River*, over Baxters' winkles, 50 yds. from shore at gas-works, tide ⅚ flood.	+	–					
54		28	4	,,	*Teign River*, ⅚ flood, between Combe Cellars and Shaldon Bridge, Boat sample.			+	–			
55		28	4	,,	*Teign River* ⅚ ebb, between Combe Cellars and Shaldon Bridge, Boat sample.				+	–		
56		28	4	,,	*Teign River* ⅚ ebb. Mussel bank, above gas works, boat sample.			+	–			
57		23	4	,,	*Teign River* Low water, opposite gas works, by Baxter's Winkle layings. Boat sample.				+	–		

Samples of Sea Water, Estuarial Water, and Water from Oyster Pits, etc.—*continued.*

3. Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				4. B. Enteritidis Sporogenes Test. Number of spores of B. Enteritidis Sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.					
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000
		(a)	(b)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
+	–	+	–			Negative 10 c.c.			
+	+	+	+			Negative 10 c.c.			
+	+	+	+	–		(? Positive 10 c.c.)			
+	+	+	+			Negative 10 c.c.			
						Negative 10 c.c.			
						Negative 10 c.c.			
+	–	+	+	–		(Positive 10 c.c.)			
+	–	+	+	–		(Positive 10 c.c.)			
+	+	+	+			Negative 10 c.c.			
+	+	+	+	+	–				
+	+	+	+	–		(Positive 10 c.c.)			
+	+	+	+	+	–				
+	+	+	+	+	–				
+	+	+	+	+	–				
+	+	+	+	+	–				

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Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

TABLE showing the Results of the Bacteriological Examination of numerous

1. DESCRIPTION OF SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.						
No.	Time of Collection.				Other Details.	+ 10 c.c.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
58		23	4	1903.	*Teign River*, Low water, underneath Shaldon Bridge, boat sample.			+	–			
59		23	4	„	*Teign River*, Low water, opposite Devon Trading Wharf. Boat sample.			+	–			
					SECTION VII.							
					The Wash at Hunstanton.							
					(Map No. 6.)							
1		23	5	„	*Hunstanton*, High water, ¼ mile from land.	–						
2		23	5	„	*Hunstanton*, Low water, ¼ mile from land.	–						
3		29	5	„	*Hunstanton*, High water, ½ mile West of Pier.	–						
4		29	5	„	*Hunstanton*, Low water, ½ mile West of Pier.	–						
5		11	6	„	*Hunstanton*, Low water, ½ mile from outfall of sewer pipe.	–						
6		11	6	„	*Hunstanton*, High water, 1 mile from Shore, opposite Sewage Works.	–						
					SECTION VIII.							
					Brancaster Staith mussel pit, *Hunstanton sea water*, over mussel beds, *The Wash*, mouth of *Witham River*. Hunstanton *Sewage effluent*.							
					(Map No. 6.)							
60		22	7	„	Mussel pit, Brancaster Staith, *not* stirred up.	+	–					
61		23	7	„	*Hunstanton*. Sea pool over mussel beds, 1 mile N. W. of Pier, Low water.	–						
62		23	7	„	*The Wash*, about ⅔ flood near Roaring Middle.	–						
63		23	7	„	*Mouth of Witham River*, dredged sample of mud and water, near Boston.		–					
64		23	7	„	*Hunstanton*, Sewage effluent at outfall.							+
					SECTION IX.							
					Firth of Forth at Gullane, shore samples.							
1	11 a.m.	22	4	„	*Firth of Forth at Gullane*, High water at Leith 10.43 a.m. Shore sample.	–						
2	12 noon.	25	4	„	*Firth of Forth at Gullane*, High water at Leith, 12.52 a.m. Shore sample.	–						

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Appendix A.

Bacteriological Examination of isolated samples Sea Water.

mples of Sea Water, Estuarial Water, and Water from Oyster Pits, etc.—*continued.*

3				4					
Chief Biological Characters of the strain of B. coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.					
Gas, Gelatine, 'shake" cultures, 24 hours t 20° C.).	Indol (Broth cultures, 5 days at 37° C.).	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.).		1	10	100	1,000	10,000	100,000
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
+	+	+	+	+	–				
+	+	+	+	–			(Positive 10 c.c.)		
							Negative 10 c.c.		
				–			(Positive 10 c.c.)		
				–			(? Negative 10 c.c.)		
							Negative 10 c.c.		
							Negative 10 c.c.		
							Negative 10 c.c.		
+	+	+	+				Negative 10 c.c.		
							Negative 10 c.c.		
							Negative 10 c.c.		
						+	–		
+	+	+	+			+	–		
							Negative 10 c.c.		
						–	(? Positive 10 c.c.)		

Division V.

Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

TABLE showing the results of the Bacteriological Examination of numerous

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas forming coli-like microbes) in 1 c.c.						
No.	Time of Collection. Hour.	Day.	Month.	Year.	Other Details.	+ 10 c.c.	1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,00 ·00001 c.c.
3	12.30 p.m.	29	4	1903.	*Firth of Forth at Gullane,* High water at Leith 3.4 p.m. Shore sample.	–						
4	10.30 a.m.	2	5	,,	*Firth of Forth at Gullane,* High water at Leith 5.27 a.m.	–						
5	11.35 a.m.	6	5	,,	*Firth of Forth at Gullane.* High Water at Leith, 10.19 a.m.	–						
6	3.30 p.m.	6	9	,,	*Firth of Forth at Gullane.* High Water at Leith, 1.7 p.m.	+	–					
					SECTION X.							
					Ribble Estuary at Lytham.							
1		3	6	,,	Ribble Estuary at *Lytham,* High Water, 5.40 p.m., from main channel, 1 mile from Pier.	+	–					
2		5	6	,,	Ribble Estuary at *Lytham,* Low Water, 1.30 p.m. ½ mile South of Lytham Pier.				+	–		
3		11	6	,,	Ribble Estuary at *Lytham.* High Water 12.7 p.m. about ½ mile from Lytham Pier.	+	–					
4		12	6	,,	Ribble Estuary at *Lytham.* 9.5 a.m. Low Water Mid-Channel off Lytham Pier.			+	–			
5		19	6	,,	Ribble Estuary at Lytham, 12.15 p.m. Low Water off Lytham Pier.			+	–			
6		20	6	,,	Ribble Estuary at *Lytham,* 6.5 p.m. High Water.	–						
					SECTION XI.							
					North Sea and English Channel.							
36	11.20 p.m.	2	4	,,	Sample of Sea Water taken by Colonel Harding from the bows of s.s. "Colchester" (one hour after leaving Pier) on the way to Antwerp.	–						
1	12.55 p.m.	23	5	,,	*North Sea.* Sample of Sea Water 5 miles out from land off Flamboro' Head (Bridlington Bay) flowing tide, nearing High Water W. ½ S.	–						
A		31	3	,,	English Channel midway between Newhaven and Dieppe.	–						
					SECTION XII.							
					Sea Water near Brighton. (Map No. 3 A).							
16		19	3	,,	*Brighton* Sea Water, 300 yards East of Portobello outfall, 2 hours after High Water.			+	–			

Bacteriological Examination of isolated samples of Sea Water.

Samples of Sea Water, and Water from Oyster Pits, etc.—*continued.*

3.				4.					
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.				B. Enteritidis Sporogenes test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anaerobic milk cultures). Cultures heated to 80° C. for 10 minutes.					
as. (Gelaine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		1	10	100	1,000	10,000	100,000
		(*a*)	(*b*)	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
				–			(Positive 10 c.c.)		
							Negative 10 c.c.		
				–			(Positive 10 c.c.)		
+	–	+	+				Negative 10 c.c.		
+	–	+	+	–			(Positive 10 c.c.		
+	+	+	+	+	–				
+	+	+	+				Negative 10 c.c.		
+	+	+	+	+	–				
+	–	+	+	+	–				
				–			(Positive 10 c.c.)		
				–			(Positive 10 c.c.)		
				–			(? Positive 10 c.c.)		
							(Negative 10 c.c.)		
+	+	+	–	–			(Positive 10 c.c.)		

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Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

It is impossible, without entering into more detail than is merited by the chance nature of the samples referred to in the foregoing table, to discuss these samples with reference to their respective liability to sewage pollution. Under the circumstances it will be of advantage to cite in regard of particular localities pages and maps in Dr. Bulstrode's report on oyster culture in relation to disease.

Section I. (Map No. 1b.)

The Emsworth oyster fisheries (Maps Nos. 20a and 20) p. 69, in Dr. Bulstrode's Report. The oyster ponds and layings on Hayling Island, and in Langston Harbour (Map No. 20), p. 70. Bosham oyster fishery (Maps No. 20 and 21), p. 72 of the same report.

Briefly stated, Langston Channel would seem to be liable to no serious pollution except from some slop water from Havant and possibly also from the sewage of Portsmouth if this is ever discharged on the flowing tide. The bacteriological results showed that two (2 and a) out of three samples contained B. coli in 10 c.c. but not in 1 c.c. The remaining sample (6) collected from the shore near the Hayling oyster fishery, contained coli-like microbes in 1 c.c. From the local surroundings it was anticipated that this sample would yield a negative result with 1 c.c.

As regards the Solent water (3 and B), sample B, as might have been expected, contained no coli-like microbes even in 10 c.c. Sample (3) contained in 10 c.c. atypical coli-like microbes derived conceivably from the Portsmouth sewage or from local drainage.

North Saltern (4) and Gutner Creeks (5) are seemingly only liable to be polluted with sewage from Emsworth, going by way of the Emsworth Channel, and indirectly by the still more remote pollution of the Chichester Channel at Chichester. Sample (5) yielded a negative result with 10 c.c. and sample (4) contained B. coli in 10 c.c., but not in 1 c.c.

The Emsworth Channel, sample (9), at Emsworth, contained 100 B. coli per c.c. One of the oyster pit samples (No. 7) contained only 1, and the other (No. 8) 10 B. coli per c.c. In view of the unfortunate history of Emsworth and of the facts revealed in Dr. Bulstrode's report, it might perhaps be anticipated that the water in these pits would yield worse results. But the pits can only be filled after the sewage from the main Emsworth sewage outfall has been enormously diluted on the flood tide with sea water, and the grave consequences which have resulted from the use of these pits have probably arisen from specific pollution of *recent* sort. It needs to be noted that sample 9, although collected only 7 yards below the main sewer outfall at about half flood tide, contained only 100 B. coli per c.c., and this water must, before replacing in the oyster pits the water brought up by the previous tide needs become greatly diluted. But it is, after all, a fact that the particular samples of water taken from these two oyster ponds were, on the date in question, from ten thousand to one hundred thousand times purer (*qua* bacteriological results) than sewage. That a pollution trivial in amount but specific in character is much more dangerous than a contamination gross in amount but non-specific in nature is obvious. It is also probable that a pollution trivial in amount but specific in character and of *recent* sort is more dangerous than a contamination gross in amount, specific in character, but of *remote* kind. To put it tersely, the shorter the circuit between the specifically diseased bowel and the mouth of the consumer of water or shellfish, the more grave is the danger. The bacteriologist can do no more than measure the degree of sewage pollution, and hence, inferentially, the probable degree of potential danger to health. His B. coli results have a presumptive but certainly not a constant value in relation to disease. All waters yielding 10 B. coli per c.c. may be placed in the same class *qua* bacteriological facts, but it is not to be thought of that they all need be of the same class *qua* morbific effect.

The water in the Bosham oyster pit (No. 10) contained no B. coli in 1 c.c.; unfortunately no 10 c.c. culture was made.

Bacteriological Examination of isolated samples of Sea Water.

Section II. (Maps Nos. 2 and 3A.)

As regards the Southwick and Shoreham samples reference should be made to Dr. Bulstrode's report as under :—

Shoreham Harbour (Map No. 92), p. 72. Southwick Oyster Layings and Storage Ponds, p. 73.

It is obvious from Dr. Bulstrode's report that the Southwick oyster ponds were formerly liable to serious pollution, and Dr. Newsholme also drew frequent attention to the same fact.

As regards sample 12, it is interesting to note that within a few yards of the spot where the sample was collected some men were collecting mussels, but whether for bait or human consumption was uncertain. The sample contained 100 B. coli per c.c. The water in Southwick Channel (No. 14) opposite the oyster ponds contained 10 B. coli per c.c.

As regards the water in the oyster ponds, one sample (13) contained B. coli in 1 c.c. The other sample (15) yielded a negative result with 1 c.c.; unfortunately no 10 c.c. culture was made, as it was anticipated that B. coli would certainly be present in 1 c.c.

Although in no way impugning the validity of Dr. Bulstrode's and Dr. Newsholme's conclusions, I am inclined to think that, despite the gross pollution of the River Adur, the river water must be greatly diluted with sea water before gaining access to the oyster ponds.

Moreover, since Dr. Bulstrode's report was written the drains which used to discharge close to the oyster ponds, have it is believed, been diverted.

Section III. (Map No. 4.)

The reference here to Dr. Bulstrode's report is as follows :—

The oyster fisheries of the Crouch and Roach Rivers (Map No. 2), pp. 33 to 36.

Some idea of the nature of the polluting matters entering the Crouch Channel may be gathered from the results of the analyses of samples Nos. 18, 19, and 21, which contained 1,000, 100,000 and 100,000 B. coli or coli-like microbes respectively per c.c. The beneficial effects of dilution are, however, shewn by the result of the analyses of Samples 17, 22 and 23. Samples 17 and 22 contained no coli-like microbes of any sort in 10 c.c. Sample 23, collected much nearer the Burnham sewage outfall works, contained B. coli in 10 c.c., but not in 1 c.c.

As regards the River Roach, samples 25 and 26 contained no B. coli in 10 c.c.; sample 24 contained coli-like microbes in 10 c.c., but not in 1 c.c.

The foregoing results are, I think, in agreement with the conclusions of Dr. Bulstrode based on former accurate topographical survey of the localities in question.

Further samples of water and also samples of oysters have been obtained from the Crouch and Roach rivers. These will be considered elsewhere (*see* App. C.).

SECTION IV. (Map No. 5.)

The reference under this section to Dr. Bulstrode's report is as follows :—

The River Colne Oyster Fishery (Maps Nos. 4, 5 and 6), pp. 38 to 41.

The Brightlingsea Creek sample (27) contained less (1 per c.c.) and the river Colne sample (28) relatively more (1 per c.c.) coli-like microbes than might be anticipated from Dr. Bulstrode's report, and the local observations of the Commission. The coli-like microbe, however, derived from the latter sample gave no indol in broth culture and no clot in litmus milk. Further, the conditions have been altered since 1894. In 1894 the Brightlingsea crude sewage was discharged directly over the oysters. Now the effluent from the sewage works is supposed to be discharged on the ebb of the tide, and the position of the outfall is different.

The tank effluent (Ives' patent) at Brightlingsea contained 100,000 B. coli per cc. (Sample No. 31). The futility of treatment of this kind in removing the

Bacteriological Examination of isolated samples of Sea Water.

objection to discharging sewage into estuaries in the neighbourhood of oyster layings is well exemplified by the foregoing result.

As regards the Pyfleet samples (29, 30 and 35) all contained B. coli in 10 c.c.

In this connection Dr. Bulstrode says :

> "After a careful consideration of all the facts, and taking into account the set of the tides "in the Colne, it appears to me that oysters laid down in the Pyfleet or stored in the pits on "Peewitt Island, are practically free from risk of pollution."

The bacteriological facts are not therefore in strict agreement with Dr. Bulstrode's conclusions. For, although the foregoing three samples contained B. coli only in 10 c.c. of the water, certain other samples both of water and oysters (*see* App. C.) subsequently obtained yielded results not quite in harmony with the topographical surroundings of the Pyfleet Channel.

Section V. (Map No. 5.)

The referece here to Dr. Bulstrode's report is as follows :—

The Blackwater and Mersea Oyster Beds (Map No. 3), p. 36.

. Two samples (32 and 33) were collected from the Strood Channel nearly opposite the Victory Inn. Neither contained coli-like microbes of any sort in 10 c.c.

Samples 34 and 34a were collected from one of Mr. Bean's oyster pits. Both contained coli-like microbes in 10 c.c.

Samples of oysters and of water were subsequently obtained from the locality, but the results will be considered elsewhere in the report. (*See* App. C.)

Section VI. (Map No. 3B.)

Samples (51 to 59) were collected from the Teign river, because whelks. mussels, winkles, and cockles are to be found there in great abundance. On page 89 of Dr. Bulstrode's report will be found a reference to certain cases of enteric fever traced by Dr. F. Cecil Piggot, Medical Officer for Teignmouth, in 1894, to the consumption of cockles or mussels obtained in proximity to the outfall drain into the Teign river of the Infectious Diseases Hospital.

Two samples (51 and 53) contained B. coli in 10 c.c.

Four samples (54, 56, 58 and 59) contained B. coli in $\frac{1}{10}$ c.c.

Three samples (52, 55 and 57) contained B. coli in $\frac{1}{100}$ c.c.

All the samples (excepting samples, 51, 53 and 59) contained the spores of B. enteritidis sporogenes in 1 c.c.

Section VII. (Map No. 6.)

These six samples were kindly collected by Dr. C. W. T. E. Whitty. The Wash at Hunstanton was chosen for the experiments, as in this region the amount of pollution of the sea water is almost negligible, and it was desired to ascertain whether in localities of this sort B. coli is absent or of rare occurrence. It is true that the Hunstanton sewage effluent, containing 100,000 B.coli per c.c. (see 64, Section VIII), is discharged into the sea near Hunstanton. But the volume of the effluent is too small to cause any serious or wide-spread pollution of the surrounding sea water.

None of the six samples contained coli-like microbes of any sort in 10 c.c.

Section VIII. (Map No. 6.)

Sample 64 has already been referred to in the previous section. Sample 60 was collected because some question had arisen of the possible pollution of the mussel pits in this locality. B. coli was present in the pit-water in 10 c.c. but not in 1 c.c.

Division V.

Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

Sample 61 was collected from one of the pools left by the tide and containing mussel beds. It was remotely possible that the Hunstanton sewage outfall, although over a mile distant, might contaminate these beds. But no coli-like microbes of any sort were present in 10 c.c.

As regards Sample 63, this was collected because serious complaint had been made of the "dumping down" of sludge in this region. B. coli was absent from 1 c.c. of the sample, but the spores of B. enteritidis were present in $\frac{1}{100}$ c.c. Probably this indicates the survival of the spores of this anaerobe after the extinction of the non-sporing B. coli.

Section IX.

These samples were collected from the shore at different states of the tide at Gullane (about five miles from North Berwick). The Firth of Forth is very wide at this point, and may be taken as representing nearly pure sea water.

Five out of the six samples contained no coli-like microbes of any sort in 10 c.c. The remaining sample contained B. coli (or a coli-like microbe) in 10 c.c.

Section X.

The Ribble is an example of a polluted river and estuary. The samples were kindly collected by Dr. Fisher. It was at one time proposed to obtain samples from all the large estuaries round the English coast, but this project had to be abandoned under pressure of other work. It will be noted that, whereas the high-water samples yielded satisfactory results, the low-water samples contained B. coli either in $\frac{1}{10}$ or $\frac{1}{100}$ c.c. *The importance of obtaining samples of sea water and estuarial water at different states of the tide, is illustrated by these results.*

Sections XI. and XII. (Map No. 3a.)

Samples 36, 1, and A contained no coli-like microbes of any sort in 10 c.c., as might have been anticipated from the localities whence they were derived. Nevertheless sample 36 yielded a seemingly positive, and sample 1 a query positive, result with the B. enteritidis sporogenes test.

Sample 16 (Section XII.) contained coli-like microbes in $\frac{1}{10}$ c.c.

It was contemplated at one time that the sea water at a number of seaside resorts where bathing is customary, and where there is a possibility or probability of sewage pollution, would be made the subject of bacteriological study. But pressure of other work rendered this impossible.

Exceptional cases apart, I think it will be considered that the bacteriological results are usually broadly parallel with the topographical surroundings of the places whence the samples were derived. When anomalous, or seemingly anomalous, results have been obtained, it should not too readily be assumed that in all such cases bacteriology is necessarily at fault. A seemingly aberrant result would seem to suggest the desirability of a revision or reconsideration of the conclusions based on topographical observations or to indicate a fresh inspection of the locality, lest the anomaly were more apparent than real. Upon the whole, as few bacteriologists would care to express an opinion on the examination of chance samples, the foregoing results deserve to be considered, collectively as well as individually, before coming to any final decision as regards the practical value of the bacteriological examination of estuarial waters.

Finally, with a view of rendering a general survey of all the results as regards B. coli comparatively easy, the samples have been grouped (irrespective of the biological attributes of the coli-like microbes) in separate classes (−10 c.c. ; + 10 c.c., − 1 c.c. ; + 1 c.c., −·1 c.c. ; + ·1 c.c. − ·01 c.c. ; + ·01 c.c., − ·001 c.c. ; + ·001 c.c. − ·0001 c.c. ; + ·0001 c.c. ; − ·00001 c.c. ; + ·00001 c.c.) as follows :—

Division V.

Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

B. coli test.—Samples yielding a negative result with 10 *c.c. of the sample.*

No.
5. Gutner Creek, oyster pond.
B. Solent, midway between Ryde and Southsea piers.
17. Crouch River, 1 mile above Burnham.
22. Crouch River, fattening beds at mouth of river.
25. Roach River, Barling Creek, top of fishery.
26. Roach River, storage pit at Poole Creek.
32. Blackwater, Strood Channel, opposite Victory Inn.
33. ,, ,, ,, 100 yards higher up.
1. Hunstanton, high water, $\frac{1}{4}$ mile from land.
2. ,, low ,, ,, ,,
3. ,, high ,, $\frac{1}{2}$ mile west of pier.
4. ,, low ,, ,, ,, ,,
5. ,, ,, ,, ,, from sewage outfall.
6. ,, high ,, 1 mile from shore opposite sewage works.
61. ,, sea pool over mussel beds, 1 mile N.W. pier.
62. The Wash, about $\frac{2}{3}$ flood tide, near Roaring Middle.
1. Firth of Forth at Gullane, shore sample.
2. ,, ,, ,, ,,
3. ,, ,, ,, ,,
4. ,, ,, ,, ,,
5. ,, ,, ,, ,,
6. Ribble Estuary at Lytham, boat sample, high water.
36. North Sea, opposite Harwich, some miles out to sea.
1. ,, ,, off Flamboro' Head, 5 miles out.
A. English Channel, midway between Newhaven and Dieppe.

B. coli test.—Samples yielding a positive result with 10 c.c., *but a negative result with* 1 *c.c. of the sample.*

No.
2. Langston Channel, flood tide near ferry.
3. Solent Water, shore sample, opposite Grand Hotel.
4. North Saltern Creek, near mouth of Emsworth Channel.
A. Langston Channel, flood tide near ferry.
23. Crouch River, at Holliwell, 3 parts flood tide.
24. Roach River, at White House fattening beds, high water.
29. Pyfleet Channel, opposite packing house. $\frac{2}{3}$ flood tide.
30. Pyfleet oyster pit, No. 23, near packing house.
35. Pyfleet Channel, head of channel, about high tide.
34. West Mersea, Mr. Bean's oyster pit.
34A. ,, ,, but mud stirred up.
51. Teign River under Shaldon Bridge, $\frac{2}{3}$ flood tide.
53. ,, ,, opposite gas works, $\frac{5}{6}$ flood tide.
60. Brancaster Staith, mussel pit.
6. Firth of Forth, at Gullane, shore sample.
1. Ribble estuary at Lytham, high water 1 mile from pier.
3. ,, ,, ,, ,, ,, ,, $\frac{1}{2}$,, ,, ,,
10. Bosham, oyster pit.
15. Southwick, one of Brazier's oyster ponds, low water
63. Mouth of Witham River, dredged sample of mud and water.

The last three samples yielded a negative result with 1 c.c. of the sample, but no 10 c.c. cultures were made.

Division V.

Appendix A.

Bacteriological Examination of isolated samples of Sea Water.

***B. coli test.*—Samples yielding a positive result with* 1 *c.c., but a negative result with* $\frac{1}{10}$ *c.c.* (1 *not* 10 *in* 1 *c.c.*)**

No.
6. Langston Channel, near high tide, near Hayling fishery.
7. Emsworth longshore oyster pit (Kennet).
11. Chichester Channel, Del Quay, about high water.
13. Southwick, one of Brazier's oyster ponds, low water.
27. Brightlingsea Creek, over private layings, 2 hours flood.
28. Colne Channel, extreme point of fishery, 2 to 3 hours flood.

***B. coli test*—*Samples yielding a positive result with* $\frac{1}{10}$ *c.c., but a negative result with* $\frac{1}{100}$ *c.c.* (10 *not* 100 *in* 1 *c.c.*)**

No.
8. Emsworth longshore oyster pit, Foster.
14. Southwick Channel, opposite Brazier's ponds, $\frac{1}{4}$ flood.
20. Burnham, pile house, Gutter Creek.
54. Teign River, between Combe Cellars and Shaldon Bridge, $\frac{5}{6}$ flood.
56. ,, ,, mussel bank above gas works, $\frac{5}{6}$ ebb tide.
58. ,, ,, underneath Shaldon Bridge, low water.
59. ,, ,, opposite Devon trading wharf, low water.
4. Ribble estuary at Lytham, off pier, low water.
5. ,, ,, ,, ,, ,, .
16. Sea-water off Brighton, 300 yards east of Portobello outfall.

***B. coli test.*—*Samples yielding a positive result with* $\frac{1}{100}$ *c.c., but a negative result with* $\frac{1}{1000}$ *c.c.* (100 *not* 1,000 *in* 1 *c.c.*)**

No.
9. Emsworth Channel 7 yards below sewer outfall, $\frac{1}{2}$ flood tide.
12. Shoreham Channel, just above Norfolk Bridge, near low tide.
52. Teign River, about 2 miles above Shaldon Bridge by Combe Cellars, $\frac{2}{3}$ flood tide.
55. Teign River, between Combe Cellars and Shaldon Bridge, $\frac{5}{6}$ ebb tide.
57. ,, ,, opposite gas works, low water.
2. Ribble Estuary, at Lytham, $\frac{1}{2}$ mile south of pier, low water.

***B. coli test.*—*Samples yielding a positive result with* $\frac{1}{1000}$ *c.c., but a negative result with* $\frac{1}{10000}$ *c.c.* (1,000 *not* 10,000 *in* 1 *c.c.*)**

No. 18. Burnham fine bed effluent.

***B. coli test.*—*Samples yielding a positive result with* $\frac{1}{10000}$ *c.c., but a negative result with* $\frac{1}{100000}$ *c.c.* (10,000 *not* 100,000 *in* 1 *c.c.*)**

No samples come under this category, but the heading is retained for the sake of uniformity.

***B. coli test.*—*Samples yielding a positive result with* $\frac{1}{100000}$ *c.c.* (*at least* 100,000 *per c.c.*)**

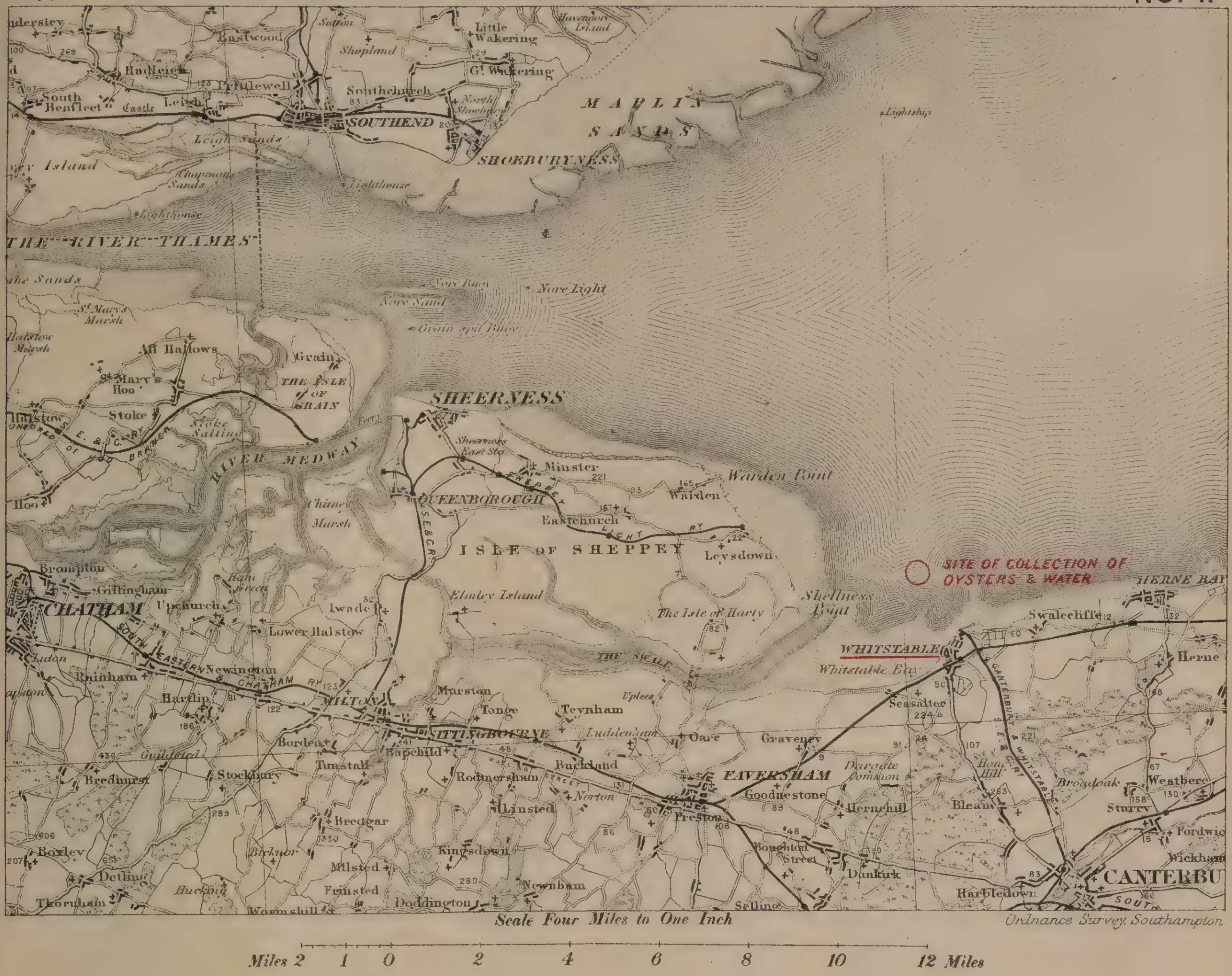
No.
19. Burnham, combined effluent.
21. Burnham, mixed effluent and sea water at sluice.
31. Brightlingsea, tank effluent, Ives' patent.
64. Hunstanton sewage effluent, at outfall.

---

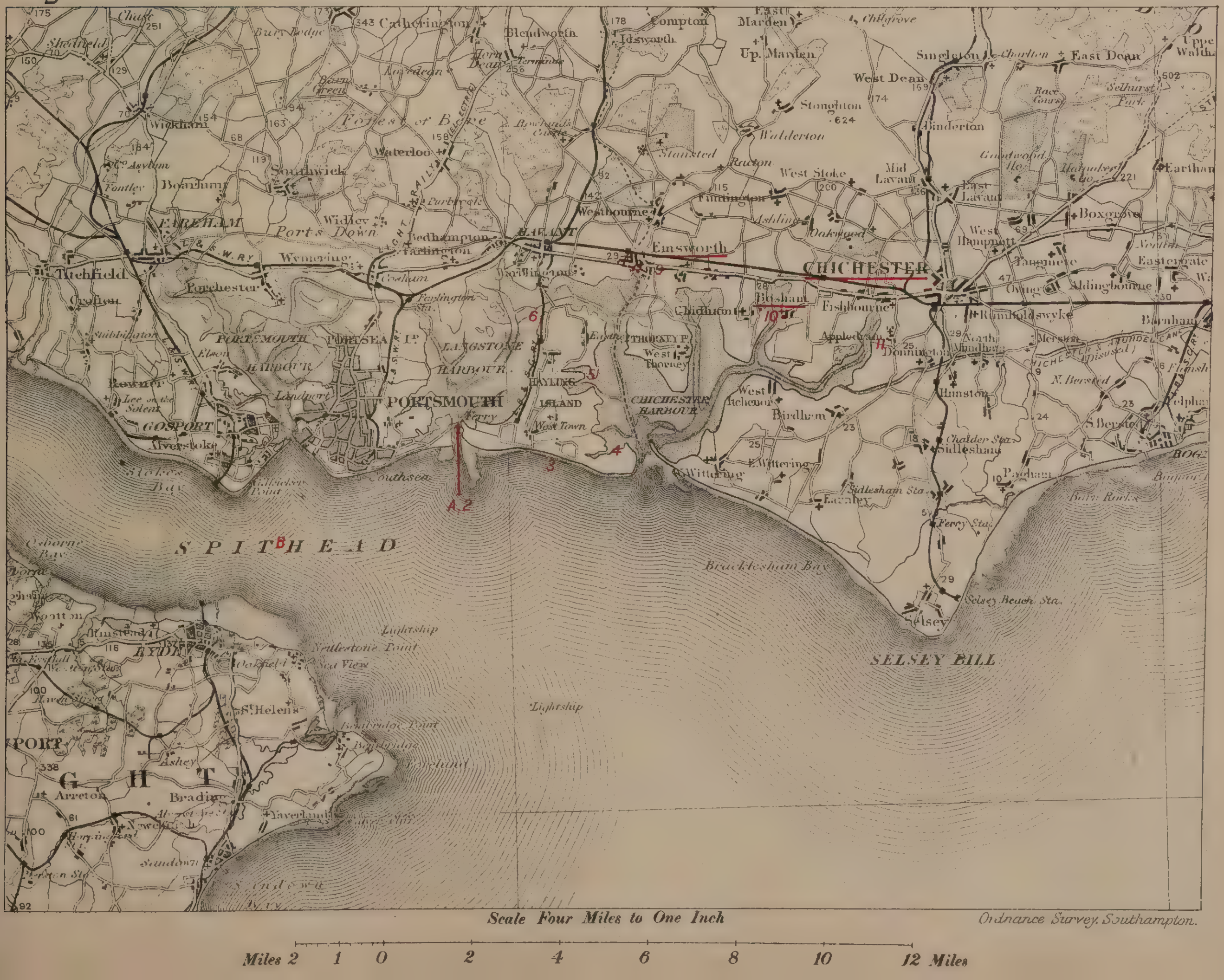
* According to the tentative standard of a negative result with 1 c.c. (*see* Division III), all the samples on the left-hand page would be passed, and all the samples on the right-hand page rejected bacteriologically. That is, if the numerical results, as regards B coli and coli-like microbes, be considered independently of the biological attributes of such microbes.

A

NO. I.


SOUTHEND
SHOEBURYNESS
MAPLIN SANDS
THE RIVER THAMES
Nore Light
SHEERNESS
THE ISLE OF GRAIN
RIVER MEDWAY
QUEENBOROUGH
ISLE OF SHEPPEY
Warden Point
Leysdown
Shellness Point
SITE OF COLLECTION OF OYSTERS & WATER
HERNE BAY
WHITSTABLE
Whitstable Bay
Swalecliffe
Herne
Seasalter
CHATHAM
Gillingham
SITTINGBOURNE
FAVERSHAM
THE SWALE
The Isle of Harty
CANTERBURY
Scale Four Miles to One Inch
Ordnance Survey, Southampton.
Miles 2 1 0 2 4 6 8 10 12 Miles

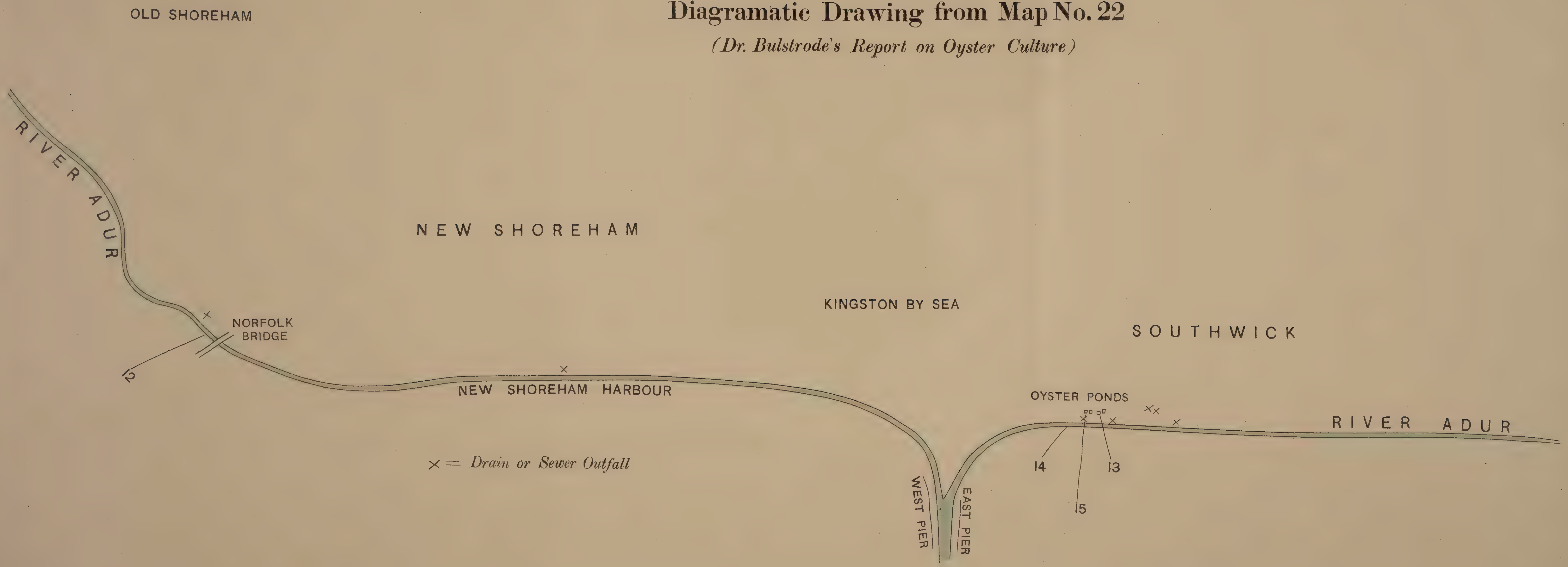
B


Forest of Bere
FAREHAM
Ports Down
HAVANT
Emsworth
CHICHESTER
Bosham
10
11
9
6
5
4
3
A.2
B
LANGSTONE HARBOUR
PORTSMOUTH HARBOUR
PORTSMOUTH
HAYLING ISLAND
CHICHESTER HARBOUR
THORNEY I.
GOSPORT
Southsea
SPITHEAD
Bracklesham Bay
SELSEY BILL
RYDE
Scale Four Miles to One Inch
Ordnance Survey, Southampton.
Miles 2 1 0 2 4 6 8 10 12 Miles

No. 2.

Diagramatic Drawing from Map No. 22

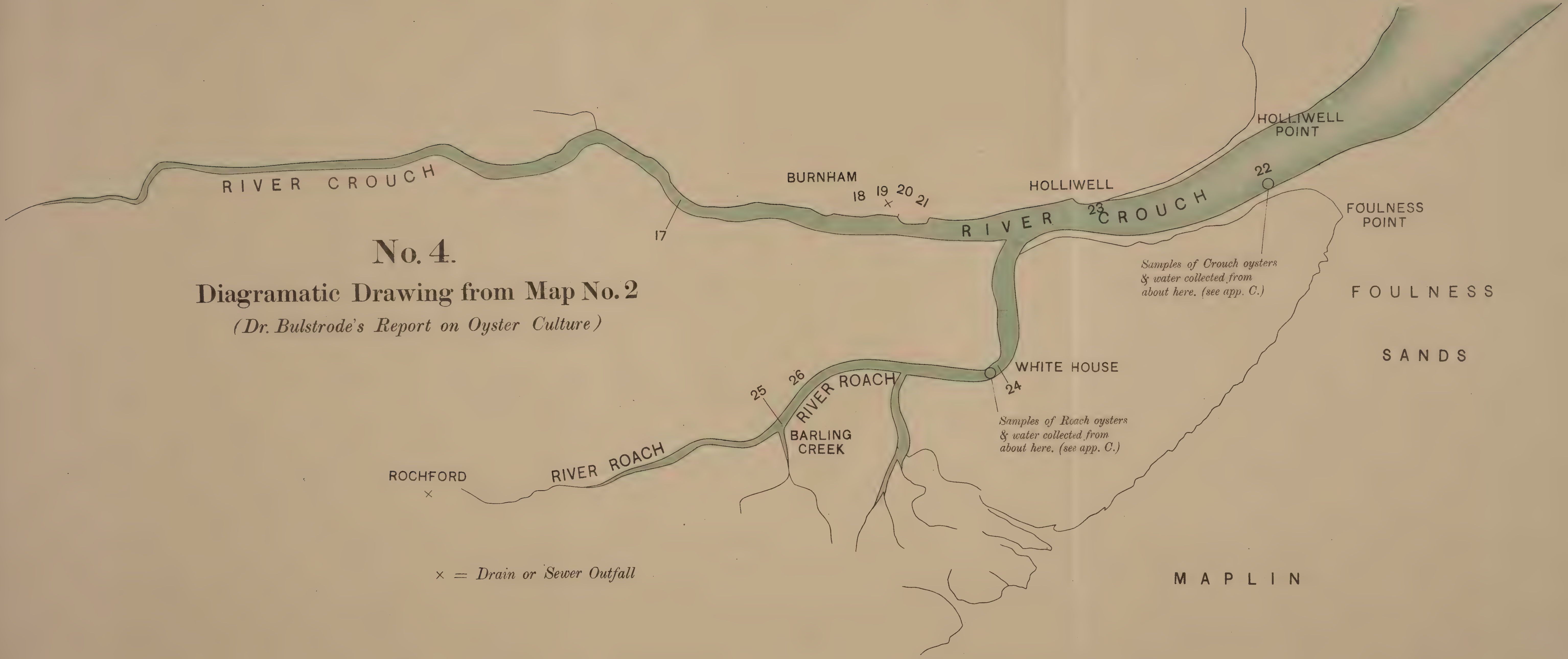
(Dr. Bulstrode's Report on Oyster Culture)



No. 4.

Diagramatic Drawing from Map No. 2

(Dr. Bulstrode's Report on Oyster Culture)



Samples of Crouch oysters & water collected from about here. (see app. C.)

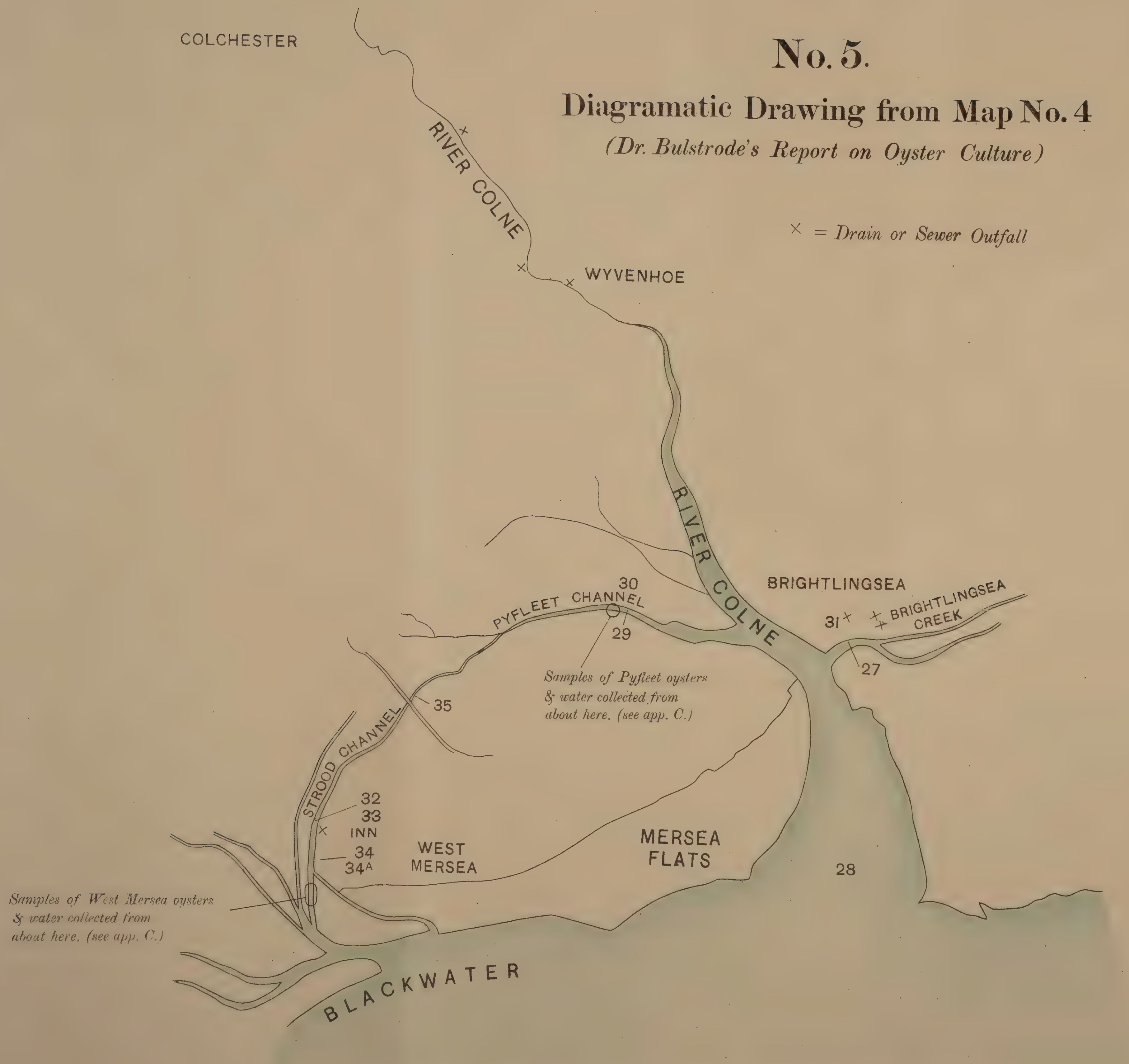
Samples of Roach oysters & water collected from about here. (see app. C.)

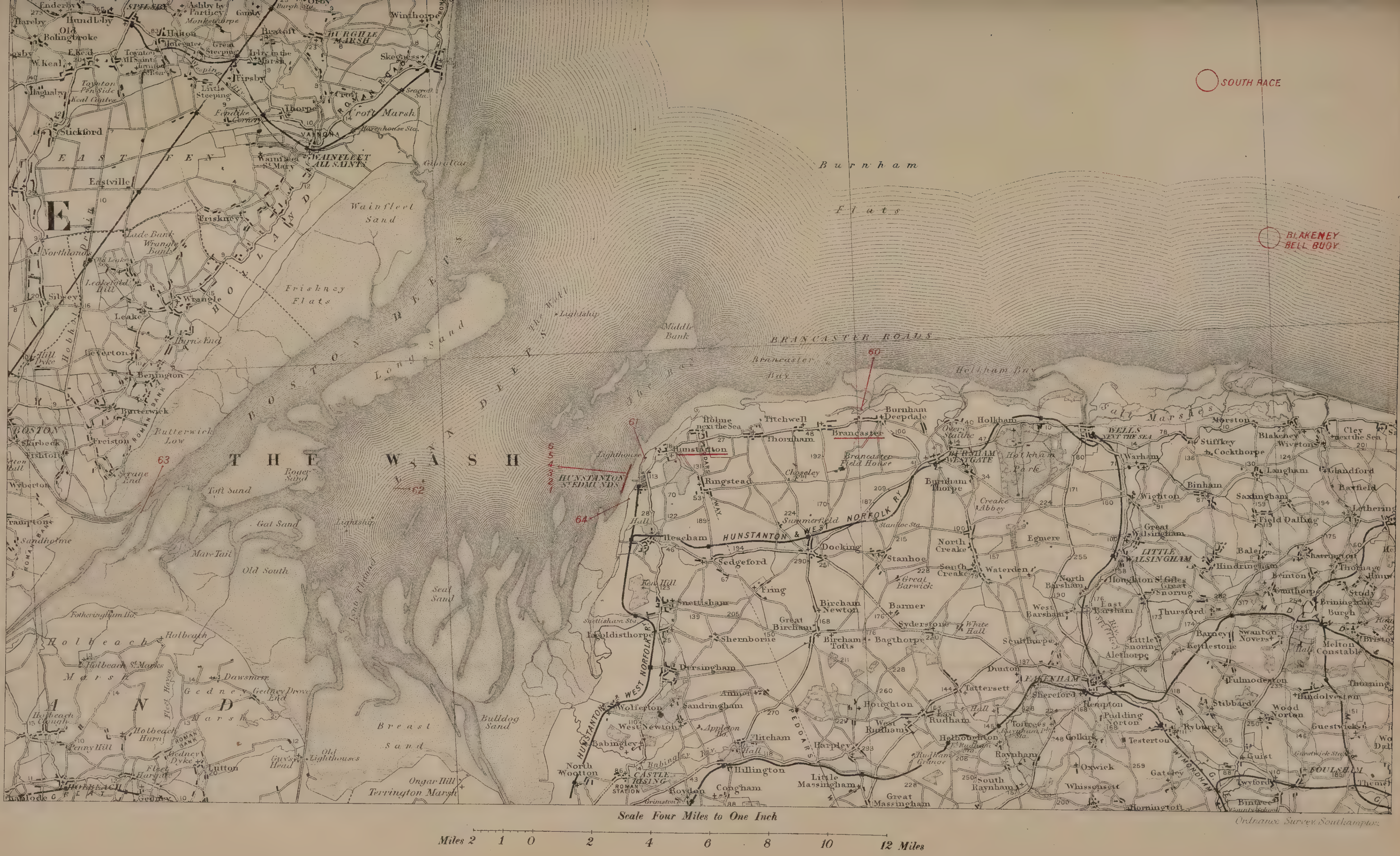
× = *Drain or Sewer Outfall*

No. 5.

Diagramatic Drawing from Map No. 4

(Dr. Bulstrode's Report on Oyster Culture)


× = Drain or Sewer Outfall
COLCHESTER
RIVER COLNE
WYVENHOE
RIVER COLNE
BRIGHTLINGSEA
BRIGHTLINGSEA CREEK
31
27
30
PYFLEET CHANNEL
29
Samples of Pyfleet oysters & water collected from about here. (see app. C.)
35
STROOD CHANNEL
32
33
INN
34
34A
WEST MERSEA
MERSEA FLATS
28
Samples of West Mersea oysters & water collected from about here. (see app. C.)
BLACKWATER


THE WASH
Boston Deeps
Lynn Deeps
Long Sand
Wainfleet Sand
Friskney Flats
Burnham Flats
BRANCASTER ROADS
Brancaster Bay
Holkham Bay
Middle Bank
Lightship
The Well
Roger Sand
Toft Sand
Gat Sand
Mare Tail
Old South
Seal Sand
Bulldog Sand
Breast Sand
Old Lighthouses
Salt Marshes
SOUTH RACE
BLAKENEY BELL BUOY
60
61
62
63
64
6
5
4
3
2
1
HUNSTANTON ST EDMUNDS
Hunstanton
Brancaster
Lighthouse
BOSTON
SPILSBY
BURGH LE MARSH
Skegness
WAINFLEET ALL SAINTS
Wainfleet St Mary
Croft Marsh
Eastville
Friskney
Wrangle
Leake
Benington
Butterwick
Freiston
Holbeach
Gedney
Lutton
Terrington Marsh
Ongar Hill
EAST FEN
HOLLAND
Holme next the Sea
Titchwell
Thornham
Burnham Deepdale
BURNHAM WESTGATE
Holkham
Holkham Park
WELLS NEXT THE SEA
Stiffkey
Morston
Blakeney
Cley next the Sea
Ringstead
Heacham
Sedgeford
Docking
Stanhoe
Snettisham
Dersingham
Sandringham
Wolferton
Castle Rising
North Wootton
Hillington
Great Massingham
Little Massingham
Houghton
East Rudham
Fakenham
LITTLE WALSINGHAM
Great Walsingham
Melton Constable
FOULSHAM
HUNSTANTON & WEST NORFOLK RY
PEDDARS WAY
ROMAN BANK
Scale Four Miles to One Inch
Miles 2 1 0 2 4 6 8 10 12 Miles
Ordnance Survey, Southampton.

APPENDIX B.

Series of Experiments dealing with the Bacteriological Examination of Deep Sea Oysters and surface samples of Sea Water collected over the Oysters.

SURFACE SAMPLES OF DEEP SEA WATER.

(*See* Map No. 6, Appendix A.)

Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water.

Before considering the results of the bacteriological examination of the deep-sea oysters, it is of interest to discuss the results of the bacteriological analysis of the water over these oysters.

From Division III. of this report it will be seen that samples collected from the surface of deep sea water at a distance from land and remote from sewage pollution do not contain spores of B. enteritidis sporogenes in 10 c.c., nor do they contain coli-like microbes of any sort even in 100 c.c.

In the present instance the B. coli test was pushed still further, as large a volume as 1,000 c.c. being submitted to examination.

Water from the neighbourhood of Blakeney Bell Buoy, 4½ *miles from land (Blakeney, Norfolk Coast, North Sea).*

In Experiment I. no 1,000 c.c. cultures were made, but the result was negative as regards coli-like microbes when 100 c.c. of the water were used for cultural purposes (*see* accompanying table.)

In Experiment II. a negative result was obtained even when using for cultural purposes 1,000 c.c. of the water.

In Experiment III. a microbe indistinguishable from typical B. coli, except as regard indol formation was isolated from 100 c.c. of the water.

In Experiment IV. a microbe indistinguishable from typical B. coli except as regards indol formation and clotting of milk, was isolated from 1,000 c.c. of the water.

None of the samples yielded a positive result with the B. enteritidis sporogenes test when using for cultural purposes 10 c.c. of the water.

Water from the region of South Race Buoy, about 9 *miles from land (Blakeney Norfolk Coast, North Sea).*

In Experiment I. no 1,000 c.c. culture was made, but no coli-like microbes were present in 100 c.c. of the water.

The last three experiments (II., III., IV.) yielded results of a most satisfactory nature, inasmuch as *no coli-like microbes were found to be present even when* 1,000 *c.c. of the water were submitted to examination.*

None of the samples yielded a positive result with the B. enteritidis sporogenes test when using for cultural purposes 10 c.c. of the water.

These results, taken in conjunction with those described in Division III., go to show that B. coli and spores of B. enteritidis sporogenes form no essential part of the bacterial flora at the surface of pure sea water. Indeed, certain of the experiments (II., III., and IV., South Race Buoy water) indicate that water from the open sea collected about 9 miles from the Norfolk coast may be *at least one-hundred million times purer* (qua *bacteriological facts*) *than a sewage effluent of average quality; from* 10 *to* 100 *times purer than Whitstable sea water; from* 100 *to* 10,000 *times purer than West Mersea sea water; from* 10 *to* 1,000 *times purer than Crouch River water; from* 100 *to* 1,000 *times purer than Roach River water; and from* 1,000 *to* 10,000 *times purer than Pyfleet water derived from the neighbourhood of the oyster layings in these localities respectively.*

Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water.

DEEP SEA OYSTERS (*see* accompanying table) *EXAMINED IN THE ROUTINE MANNER* (*see* Addendum A. Helford and Penryn Report.)

Mumbles Oysters.

The first sample of deep sea oysters was obtained from Mumbles, 3½ miles from shore, Bristol Channel.*

The total number of coli-like microbes was 100 per oyster. On subculture the microbe isolated from the last dilution proved atypical, but in the last-dilution-but-one a microbe was found indistinguishable from the typical B. coli., except that clotting of the milk cultures was not well marked. From these oysters a microbe seemingly identical with B. prodigiosus was also isolated.

As regards the B. enteritidis sporogenes test the number of spores was 10 per oyster.

Not much significance is attached to this experiment, as the water in the Bristol Channel is known to be polluted.

Blakeney Bell Buoy and South Race Buoy Deep Sea Oysters.
(*See* Map No. 6, Appendix A.)

These oysters were collected 4½ and about 9 miles respectively off Blakeney, Norfolk Coast, North Sea.

Sample I. contained 10 coli-like microbes per oyster, but none of the microbes isolated from this or the lower dilution were at all typical of B. coli

Sample II. contained 1,000 coli-like microbes per oyster, but they were found to possess practically none of the characters of typical B. coli. The coli-like microbes isolated from the last-dilution-but-one were somewhat more typical in that they produced acid and gas in lactose peptone cultures.

Sample III. contained 10 coli-like microbes per oyster, but neither in the last nor in the next lower in the scale of dilutions were the microbes other than atypical.

Sample IV. contained 100 coli-like microbes per oyster, but the coli-like microbes isolated from the last three dilutions yielding coli-like microbes were markedly atypical in character.

None of the 18 coli-like microbes isolated from these samples of deep sea oysters produced indol in broth cultures or clotting in milk cultures. Only two (query three) produced gas in lactose peptone cultures. Half the coli-like microbes produced definite greenish-yellow fluorescence in neutral-red broth cultures.

As regards the B. enteritidis sporogenes test all the samples contained less than 10 spores per oyster.

Special Experiments with the Blakeney Bell Buoy and South Race Buoy Deep Sea Oysters.

In the hope of finally elucidating the problem with regard to the distribution of B. coli and coli-like microbes in individual deep-sea oysters obtained from localities remote from all sewage pollution, a large number of additional experiments were made with the Blakeney Bell Buoy and South Race Buoy oysters.

The following is a description of these experiments :—

Experiment I.

The ten oysters used for this experiment were collected on October 14th 1903, 4½ miles from land and 1 mile south of the Blakeney Bell Buoy, from a depth of 11½ fathoms, on the first quarter of the ebb tide.

The exterior of the oyster shells having been cleaned in the manner described elsewhere, the oysters were laid so as to rest on their concave shells. An area of the plane shell then uppermost was in each instance

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* No corresponding sample of water was obtained.

Division V.
Appendix B.
Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water.

mopped heavily with pure hydrochloric acid; some time after the chemical action thus set up had entirely ceased, a sterile brace bit was used to bore a hole ($\frac{3}{8}$th-inch diameter) through the prepared area of shell, in order to gain access to the oyster body without separating the two valves of shell. The points of sterile curved scissors were then introduced through the opening and used to break up the oyster body, and thus to liberate the liquid contained within it. This liquid was withdrawn with a sterile 1 c.c. pipette and from one to five cubic centimetres of the liquid added to tubes of sterile bile salt broth. This procedure was carried through in examining each of the ten oysters. It was observed in each case that during the whole process and for some time after it was completed the shell valves adhered firmly together.

A *coli-like* microbe was isolated from nine of the ten oysters (90 per cent.) by the gelatine plate method.

The several microbes presented in pure culture the following reactions:—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures.	Lactose peptone cultures.	*Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	1 c.c.	Gas N.L.	Slight acid, no gas.	Positive.	No indol.	Acid, no clot.
B	2 c.c.	Gas N.L.	Bleached, very slight gas.	Positive.	No indol.	Acid, no clot.
C	2 c.c.	Gas N.L.	Acid and gas.	Positive.	No indol.	Bleached, and clot. (? atypical.)
D	2 c.c.	Gas N.L.	Acid and gas.	$\frac{1}{2}$ positive.	No indol.	Bleached, no clot. (? atypical.)
E	2 c.c.	Gas N.L.	No acid, no gas.	$\frac{3}{4}$ positive.	No indol.	Acid, no clot.
F	2 c.c.	Gas N.L.	Acid and gas.	Positive.	No indol.	Bleached, and clot. (? atypical.)
G	4 c.c.	Gas N.L.	Acid and gas.	Positive.	No indol.	Bleached, no clot. (? atypical.)
H	5 c.c.	No coli-like microbes could be found.				
I	5 c.c.	Gas N.L.	Acid and gas.	Positive.	No indol.	Acid and clot.
J	5 c.c.	Gas N.L.	No acid no gas.	Positive.	No indol.	Acid and clot.

N.L. indicates that no liquefaction of the gelatine in the "shake" cultures had occurred after lapse of one month.

* "Positive" indicates the production of a greenish-yellow fluorescence in neutral-red broth.

The microbes derived respectively from the oysters C. F. and I (30 per cent.) bore some resemblance, when submitted to the tests detailed, to the typical B. coli of the human intestine, but the resemblance did not extend so far as the formation of indol in broth cultures.

Considered separately, the behaviour of the isolated microbes to the several tests employed was as follows:—

Lactose Peptone Test (48 hours at 37° C.)

Five oysters (50 per cent.) yielded each a microbe which produced both acid and gas in this medium. Omitting oyster H., the remaining four oysters (40 per cent.) yielded microbes behaving atypically in this medium.

Neutral-red Broth Test (48 hours at 37° C.)

Seven oysters (70 per cent.) yielded microbes which produced greenish-yellow fluorescence in neutral-red broth; two oysters (20 per cent.) yielded microbes in which the power to produce the characteristic colour was not marked.

Indol in Broth Cultures (5 days at 37° C.)

None of the microbes isolated produced indol under the above conditions.

Litmus Milk Test (5 days at 37° C.)

Four oysters (40 per cent.) yielded microbes which in addition to producing acidity or a bleached appearance in milk, caused clotting of the medium; three oysters (30 per cent.) yielded microbes which caused the production of acid in, but failed to clot, milk; two oysters (20 per cent.) yielded microbes which behaved altogether atypically in this medium.

Gas Test.

The production of gas in gelatine "shake" cultures and the non-liquefaction of the medium, in the case of pure cultures of each of the microbes isolated, established the claim of the 9 microbes to be regarded as "coli-like."

EXPERIMENT II.

The ten oysters (A, B, C, D, E, F, G, H, I, J) used for this experiment were collected on November 3rd 1903 one mile south of the Blakeney Bell Buoy, in 11½ fathoms of water at half flood tide. The oysters were tested on November 5th.

The procedure was precisely the same as that detailed in Experiment I. of this series, except that a strong sterile bent wire was used instead of the sterile curved scissors to break up the oyster body in each instance.

The cultures were made much as before by adding from each oyster from 1 to 10 c.c. of liquid to tubes of sterile bile salt broth. No one of the ten cultures yielded coli-like microbes. The actual amount of liquid added to the culture tubes from each of the ten oysters A, B, C, D, E, F, G, H, I, J was 10, 10, 7, 1, 1, 10, 9, 10, 2 c.c. respectively.

This result was unexpected in view of the results obtained in experiment I. so further experiments were instituted.

EXPERIMENT III.

The oysters used for this experiment were five of the Blakeney oysters (A, B, C, D, E), belonging to the same batch as those used for the foregoing experiment, and five oysters (F, G, H, I, J), collected on November 3rd 1903 1¼ miles north-east of the South Race Buoy, in 10½ fathoms of water, at the last quarter of the ebb tide.

The procedure was precisely the same as in Experiment I. of this series, sterile curved scissors being again used in each instance to break up the oyster body.

No one of the ten oysters, however, yielded coli-like microbes. The actual amount of liquor added to the culture tubes from each of the ten oysters, A, B, C, D, E, F, G, H, I, J, was 4, 6, 2, 10, 1, 4, 10, 7, 10, 5 c.c., respectively.

EXPERIMENT IV.

On November 7th 1903 two oysters (A and B), from the neighbourhood of the Blakeney Bell Buoy, and two oysters (C and D), from the neighbourhood of the South Race Buoy, belonging, respectively, to the same consignments as the oysters used for Experiment III., were cleansed exteriorly and opened with the precautions described elsewhere; each oyster, however, had its convex shell removed, and was left resting on its plane shell. A strong sterile platinum loop was then used to obtain access in each instance to the oyster's stomach, from which approximately $\frac{1}{10}$ c.c. of liquid was abstracted by means of a sterile pipette, and added to a tube of sterile bile salt broth. However, in no case could coli-like microbes be isolated from the stomach contents of any one of the four oysters.

Division V.

Appendix B.

Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water

Experiment V.

On November 8th 1903 the procedure of Experiment IV. was repeated with two Blakeney oysters, belonging to the same consignment as Experiments II., III., and IV. (collected November 3rd).

0·1 ($\frac{1}{10}$) c.c. of the stomach contents of each oyster was added to a separate tube containing sterile bile salt broth, which, however, on incubation yielded no coli-like microbes. It now became evident (notwithstanding the results obtained in Experiment I.), that in deep sea oysters B. coli may be either absent or, at all events, seldom detectable.

Experiment VI.

The oysters used for this experiment were five in number, and were collected on November 17th 1903 one mile south by east of the Blakeney Bell Buoy, in $11\frac{1}{2}$ fathoms at half ebb tide. The oysters were tested on November 18th.

The preliminary procedure was the same as in Experiment I. of this series, an area of the plane surface of each oyster shell being mopped with hydrochloric acid, which was, however, after some time wiped off with a sterile cloth. The sterile brace bit was used as before to obtain access to the oyster body, which was broken up with a strong sterile bent wire in the manner before described.

From the liquid withdrawn from each oyster three tubes of sterile bile salt broth were inoculated. With a sterile 1 c.c. pipette (1) 1 c.c. of liquid was withdrawn and added to a tube of bile salt broth; (2) 2 c.c. of the liquid were withdrawn and added to a second tube; (3) the pipette was used to add the residual amount of liquid from the oyster to a third tube of the same medium.

The behaviour in pure culture of the microbes isolated from these primary cultures is shown in the following table:—

Oyster.	Amount of Liquid in c.c.	Gelatine "shake" Cultures.	Lactose Peptone Cultures.	*Neutral-red Broth Cultures.	Broth Cultures.	Litmus Milk Cultures.
A	1 c.c.	No coli-like microbes could be found.				
	2 c.c.	No coli-like microbes could be found.				
	8 c.c.	Gas N.L.	Acid, slight gas.	Negative.	No indol.	Acid, no clot.
B	1 c.c.	Gas S.L.	No acid, no gas.	Negative.	No indol.	No acid, no clot.
	2 c.c.	No coli-like microbes could be found.				
	3 c.c.	Gas S.L.	No acid, no gas.	½ positive.	No indol.	No acid, no clot.
C	1 c.c. 2 c.c. 3 c.c.	No coli-like microbes could be found				
D	1 c.c. 2 c.c. 9 c.c.	No coli-like microbes could be found.				
E	1 c.c. 2 c.c. 5 c.c.	No coli-like microbes could be found.				

---

* "Positive" indicates the production of a greenish-yellow fluorescence in neutral-red broth. "Negative" indicates that this change did not occur.

N.L. signifies no liquefaction of gelatine within 1 month.

S.L. signifies slow liquefaction of gelatine within 1 month.

It is obvious from the foregoing table that the microbes isolated bore hardly any resemblance to typical B. coli.

Only two of the five oysters (40 per cent.) yielded coli-like microbes.

EXPERIMENT VII.

On November 18th the procedure of Experiment VI. was repeated with five oysters collected on November 17th, 1¼ mile north-east of the South Race Buoy, in 10½ fathoms at the last quarter of the ebb.

A coli-like microbe was isolated from 10 c.c. of the liquid derived from one of these oysters (E). None of the other oysters (A, B, C, D), yielded any coli-like microbes. The amount of liquid added to the culture media from oysters A, B, C, D, was as follows :—

A—1, 2 and 8 c.c.

B—1, 2 and 3 c.c.

C—1, 2 and 3 c.c.

D—1, 2 and 6 c.c.

The microbe isolated from oyster E yielded in pure culture the following responses to certain tests :—

Amount of Liquid in c.c.	Gelatine "Shake" Culture.	Lactose Peptone Culture.	*Neutral-red Broth Culture.	Broth Culture.	Litmus Milk Culture.
10 c.c.	Gas.†	Acid and gas.	½ positive.	Indol.	Acid, slight clot.

* "Positive" indicates the production of a greenish-yellow fluorescence in neutral-red broth.

† No liquefaction of gelatine within one month.

This microbe bears a great resemblance in its behaviour to the tests detailed to typical B. coli, but the growth in red broth of the microbe isolated and its reluctance to clot milk shewed that it was not identical with the classic type.

In this experiment only one (20 per cent.) of the oysters could be considered to contain coli-like microbes.

EXPERIMENT VIII.

The five oysters used for this experiment belonged to the series from Blakeney collected November 17th 1903 (*see* Experiment VI.).

The procedure was the same as in Experiment VI., except that corrosive sublimate solution 1 in 500 was applied instead of hydrochloric acid to the exterior of the plane shell. Before applying the sterile brace bit, the germicidal solution was wiped off with a sterile cloth.

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A coli-like microbe isolated from Oyster B., exhibited in pure culture the following characters:—

Oyster.	Amount of Liquid in c.c.	Gelatine "Shake" Cultures	Lactose Peptone Cultures.	*Neutral-red Broth Cultures.	Broth Cultures.	Litmus Milk Cultures.
A	1 c.c.	No coli-like microbes could be found.				
	2 c.c.					
	3 c.c.					
B	1 c.c.	No coli-like microbes could be found.				
	2 c.c.					
	3 c.c.	Gas †	Bleached, no gas.	Positive.	Indol (feeble).	Alkali.
C	1 c.c.	No coli-like microbes could be found.				
	2 c.c.					
	5 c.c.					
D	1 c.c.	No coli-like microbes could be found.				
	2 c.c.					
	8 c.c.					
E	1 c.c.	No coli-like microbes could be found.				
	2 c.c.					
	3 c.c.					

* "Positive" indicates the production of a greenish-yellow fluorescence in neutral-red broth.

† No liquefaction of gelatine within one month.

Only one oyster (20 per cent.) yielded a coli-like microbe, and this microbe with regard to the lactose peptone and litmus milk tests obviously departed far from the standard of classical B. coli.

EXPERIMENT IX.

The five oysters (A, B, C, D, E) used for this experiment belonged to the series from South Race Buoy collected November 17th 1903.

The procedure was the same as in Experiment VI., except that corrosive sublimate solution 1 in 500 was applied instead of hydrochloric acid to the exterior of the plane shell. Before applying the sterile brace bit, the germicidal solution was wiped off with a sterile cloth.

The amount of liquor abstracted from oysters A, B, C, D, E, and added to suitable culture media was as follows :—

A—1 c.c. 1 c.c. 2 c.c.
B—1 c.c. 2 c.c.
C—1 c.c. 2 c.c. 20 c.c.
D—1 c.c. 2 c.c. 15 c.c.
E—1 c.c. 2 c.c. 6 c.c.

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The result was totally negative as regards the presence of coli-like microbes of any sort. That is, a total of 57 c.c. of liquor derived from 5 oysters contained no coli-like microbes.

EXPERIMENT X.

The five oysters (A, B, C, D, E) used for this experiment belonged to the series from Blakeney collected on November 17th 1903.

The procedure was the same as in Experiment VI., except that instead of the hydrochloric acid a little absolute alcohol was poured on to the exterior of the plane shell. This was immediately set on fire and allowed to burn itself out.*

The results were as follows :—

Oyster.	Amount of Liquor in c.c.	Gelatine "shake" Cultures.	Lactose Peptone Cultures.	Neutral-red Broth Cultures.	Broth Cultures.	Litmus Milk Cultures.
A	1 c.c.	No coli-like microbes could be found.				
B	1 c.c. 2 c.c. 3 c.c.	No coli-like microbes could be found.				
C	1 c.c.	Gas. N.L.	Acid, no gas.	Negative results.	No indol.	Acid, no clot.
	2 c.c 4 c.c.	No coli-like microbes could be found.				
D	1 c.c. 2 c.c. 6 c.c.	No coli-like microbes could be found.				
E	1 c.c. 2 c.c. 3 c.c.	No coli-like microbes could be found.				

N.L. signifies no liquefaction of gelatine within 1 month.

It will be seen that only one oyster yielded a coli-like microbe, and the biological attributes of this microbe were of such a feeble character that its relationship to B. coli cannot conceivably be other than remote.

EXPERIMENT XI.

The five oysters (A, B, C, D, E) used for this experiment belonged to the series from the South Race Buoy collected on November 17th 1903.

---

* The heat generated by the burning alcohol would produce no appreciable effect on the shell contents of the oysters. The oysters themselves remained tightly closed for a considerable time after the experiment had been completed.

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Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water.

The procedure was the same as in Experiment X., absolute alcohol being used for sterilising the outside of the shell.

The results were as follows :—

Oyster.	Amount of Liquor in c.c.	Gelatine "Shake" Cultures.	Lactose Peptone Cultures.	Neutral-red Broth Cultures.	Broth Cultures.	Litmus Milk Cultures.
A	1 c.c. 2 c.c. 4 c.c.	No coli-like microbes could be found.				
B	1 c.c. 2 c.c. 5 c.c.	No coli-like microbes could be found.				
C	1 c.c.	No coli-like microbes could be found.				
	2 c.c.	Gas. N.L.	Acid, no gas.	§ Negative.	No indol.	Acid, no clot.
D	1 c.c. 2 c.c. 5 c.c.	No coli-like microbes could be found.				
E	1 c.c. 2 c.c. 5 c.c.	No coli-like microbes could be found.				

N.L. signifies no liquefaction of gelatine within 1 month.

§ "Negative" indicates that no greenish yellow fluorescence was produced.

It will be seen that only one oyster yielded a coli-like microbe, and that the biological attributes of this microbe were of such a feeble character that its relationship to B. coli cannot conceivably be other than remote.

CONCLUSIONS.

Judging these experiments as a whole, the conclusion seems inevitable that in deep sea oysters derived from deep sea water remote from sewage pollution B. coli and coli-like microbes and also the spores of B enteritidis sporogenes are either absent or, at all events, seldom detectable. The same is true of the surface water over such oysters.

It is nevertheless true that in shallow water near the shore around our English coast in situations practically available and well suited for the growth and fattening of high class oysters, it may be and indeed would seem to be impossible to obtain similar bacteriological results.

Yet it is necessary to start with a basis, and the basis in the present instance is that B. coli and B. enteritidis sporogenes seemingly form no essential part of the bacterial flora of pure sea water, and that they have no part in the economy of the oyster.

Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water.

I am greatly indebted to Mr. Herbert Donnison, Chief Inspector, Eastern Sea Fisheries District, for the trouble which he has taken in arranging for the collection and prompt transmission of samples of water and deep sea oysters. Without his willing co-operation and ready help, these experiments could not have been carried out.

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Appendix B.

Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water.

TABLE showing the Results of the Bacteriological Examina

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.								
No.	Time of Collection.				Other Details.	+ 1,000 c.c.	+ 100 c.c.	+ 10 c.c.	1	10	100	1,000	10,000	100,00
	Tide.	Day.	Month.	Year.					1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·0000 c.c.
I.	1st ¼ flood.	30	9	1903.	Water from the open sea (Norfolk Coast, North Sea). Collected off Blakeney Bell Buoy S. by E. 1 mile, 11 fathoms, 4½ miles from land. (*See* map.)		–							
II.	1st ¼ ebb.	14	10	,,	Water from the open sea (Norfolk Coast, North Sea). Collected 1 mile South of Blakeney Bell Buoy, 11½ fathoms.	–								
III.	Half flood.	3	11	,,	Water from the open sea (Norfolk Coast, North Sea). Collected 1 mile south of Blakeney Bell Buoy, 11½ fathoms.		+	–		Characters of coli from lower dilution.				
IV.	Half ebb.	17	11	,,	Water from the open sea (Norfolk Coast, North Sea.) Collected S. by E., 1 mile from Blakeney Bell Buoy.	+	–							
I.	Half flood.	30	9	1903.	Water from the open sea (Norfolk Coast, North Sea). Collected 1¼ miles N.E. of South Race Buoy, 10 fathoms, about 9 miles from land. (*See* map.)		–							
II.	Half ebb.	14	10	,,	Water from the open sea (Norfolk Coast, North Sea). Collected 1¼ miles North of South Race Buoy, 10½ fathoms.	–								
III.	Last ¼ ebb.	3	11	,,	Water from the open sea (Norfolk Coast, North Sea). Collected 1¼ miles N.E. of South Race Buoy, 10½ fathoms.	–								
IV.	Last ¼ ebb.	17	11	,,	Water from the open sea (Norfolk Coast, North Sea). Collected 1¼ miles N.E. of South Race Buoy, 10½ fathoms.	–								

on of Surface Samples of Deep Sea Water.

3. Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.						4. B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						5.
Gas. Gelatine shake" ultures, 4 hours t 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.) (a)	(b)	Lactose peptone medium. + = acid and gas, 48 hours at 37° C.	Neutral-red broth. + = greenish-yellow fluorescence, 48 hours at 37° C.	1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.	REMARKS.
								Negative 10 c.c.				All the samples were collected about 4½ miles from land.
								Negative 10 c.c.				They were all surface water samples.
+N.L.	–	+	+	+	+			Negative 10 c.c.				N.B. — Water Sample No. I., from Blakeney Bell Buoy, corresponds with No. I., Blakeney Bell Buoy oysters.
+N.L.	–	+	–	–	–							
+N.L.	–	+	–	+	+			Negative 10 c.c.				
.L. signi- s no lique- ction, one month.												
								Negative 10 c.c.				All the samples were collected about 9 miles from land.
								Negative 10 c.c.				All were surface water samples.
								Negative 10 c.c.				N.B. — Water Samples Nos. I., II., and III., from South Race Buoy, correspond with oyster Nos. II., III., and IV., of South Race Buoy.
								Negative 10 c.c.				

Division V.

Appendix B.

Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water.

TABLE showing the Results of

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming col like microbes) in 1 c.c. per Oyster (average of 10 Oysters).					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100
	Tide.	Day.	Month.	Year.							
A		18	9	1903	Oysters from deep water, 3½ miles from shore (Mumbles, Bristol Channel).			+	−		
						Characters of coli from lower dilution					
I.	1st ¼ flood	30	9	1903	Deep sea oysters collected from near Blakeney Bell Buoy, S. by E., 1 mile, 11 fathoms, 4½ miles from Norfolk coast (Blakeney, North Sea).		+	−			
						Characters of coli from lower dilution					
II.	½ flood	30	9	1903	Deep sea oysters collected 1¼ miles N.E. of South Race Buoy (off Norfolk coast, North Sea), 10 fathoms, about 9 miles from land.				+	−	
						Characters of coli from lower dilution.					
III.	½ ebb	14	10	1903	Deep sea oysters collected 1¼ miles north of South Race Bouy (off Norfolk coast, North Sea), 10½ fathoms, about 9 miles from land.		+	−			
						Characters of coli from lower dilution.					
IV.	¾ ebb	3	11	1903	Deep sea oysters collected 1¼ miles N.E. of South Race Buoy (off Norfolk coast, North Sea), 10½ fathoms, about 9 miles from land.			+	−		
						Characters of coli from next to last diluti					
						Ditto, last dilution but two.					

Bacteriological Examination of Deep Sea Oysters and unpolluted Sea Water.

eriological Examination of Deep Sea Oysters.

	3.					4.						5.
	Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.					B. Enteritidis Sporogenes Test. Spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures) per Oyster average of 10 Oysters). Cultures heated to 80° C. for 10 minutes.						REMARKS.
s. tine ke" res, ours ° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium + = acid and gas, 48 hours at 37° C.	Neutral-red broth cultures + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(a)	(b)									
L.	–	+	–	–	–		+	–				Volume of oysters = 130 c
L.	+	+	+ (slight)	+	+							
N.L.	–	+	–	–	+	Less than 10.			Negative 10 c.c.)			Volume of 10 oysters = 225 c.c.
N.L.	–	+	–	–	½ –							
N.L.	–	+	–	slight acid ? gas.	+							
N.L.	–	+	–	–	½ –							
N.L.	–	+	–	–	–	Less than 10.			(Negative 10 c.c.)			Volume of 10 oysters = 260 c.c.
N.L.	–	+		–	–							
N.L.	–	+	–	+	–							
N.L.	–	+	–	+	? –							
N.L.	–	+	–	–	+	Less than 10.			(Negative 10 c.c.)			Volume of 10 oysters = 330 c.c.
N.L.	–	+	–	–	+							
N.L.	–	+ slight.	–	–	+							
N.L.	–	+	–	–	–							
N.L.	–	– Atypical	–	–	–	Less than 10.			(Negative 10 c.c.)			Volume of 10 oysters = 220 c.c.
N.L.	–	Atypical		–	+							
N.L.	–	+ slight	–	–	¾ +							
N.L.	–	+ slight	–	–	+							
N.L.	–	+	–	–	–								N.B. — No. I., Blakeney Bell Buoy oysters, corresponds with No. I, Blakeney Bell Buoy water sample. Nos. II., III. and IV., South Race Buoy oysters, correspond with Nos. I., II., and III. South Race water samples.
N.L.	–	+	+	–	+							
signi- no efac- one nth. - signi slow efac- one nth.												

APPENDIX C.

Results of the Bacteriological Examination of Samples of Whitstable, West Mersea, Crouch, Roach, and Pyfleet oysters and corresponding samples of water.

APPENDIX C.

Division V.

Appendix C.

Bacteriological Examination o Whitstable, W Mersea, Crouc Roach and Pyfleet Oysters and Waters.

The results of the bacteriological examination of samples of Whitstable, West Mersea, Crouch, Roach, and Pyfleet oysters, and of corresponding samples of water, are shewn in the accompanying tables.* 200 oysters were examined altogether, in four separate batches of ten oysters from each of the foregoing five localities. Twenty corresponding samples of water collected over the layings were examined altogether; four from each of the above-named five localities.

The Whitstable and Pyfleet oysters are known all over the world, and the West Mersea, Crouch and Roach oysters are probably no whit inferior in quality. No outbreak of enteric fever has ever, it is believed, been traced to the consumption of oysters from these layings. At the great annual Colchester oyster feast, tens of thousands of Pyfleet oysters are consumed in one day. The general topographical surroundings of these oyster layings have been either unconditionally approved or the layings considered so far removed from *recent* sewage pollution as to be practically safe. These practical considerations should be borne in mind in scrutinising the results of the bacteriological examinations. The West Mersea, Crouch, Roach and Pyfleet layings have been personally inspected by the Commissioners.

WHITSTABLE LAYINGS.†

On page 76 of his report on oyster culture in relation to disease, Dr. Bulstrode, in judging the liability of the Whitstable oyster layings to sewage pollution, says§ :—

> "As regards the layings themselves, they lie out at sea; the Pollard layings are over 1 mile to about 2 miles from the sewer outfalls, the Ham layings are about 3½ miles away; and they must, it seems to me, be regarded as practically free from liability to contamination with Whitstable sewage. The sludge from the London Sewage Works is deposited in Barrow Deeps, distant some 9 or 10 miles from these layings."

WEST MERSEA LAYINGS.†

As regards the West Mersea oyster layings, it is of advantage to quote from pages 37 and 38 of Dr. Bulstrode's report as follows :—

> "The main polluting agency of the Blackwater is the sewage of Maldon, a town with a population, at the last (1891) census, of 5,397. The sewage is conducted some distance outside of the town, and is held up during high water in storage tanks, the only treatment to which it is subjected being a coarse screening. The sewage, after screening, is discharged into a creek on the marshes, and eventually finds its way into the Blackwater at a point some 12 miles distant from its mouth, near Mersea Island.
>
> At Heybridge, opposite Maldon, a large portion of the sewage of Heybridge passes into a creek, which shortly afterwards joins the Blackwater. At one point along this creek are a number of privies discharging direct on to the foreshore * * * *. At Heybridge Basin, a small group of houses discharges sewage direct into the Blackwater.
>
> The village of Tollesbury discharges its slop and storm water (excrement is disposed of chiefly by pails and privies) by means of two outfalls. The larger of these two empties itself on to the marshes, and some of the sewage in all probability finds its way, after a sinuous course, into Woodroffe Creek, a tributary of Tollesbury Fleet. In Woodroffe Creek there are no oysters laid down. At the time of my visit to this outfall, when I was accompanied by Dr. Thresh, the County Medical Officer of Health, but little sewage was escaping from it, and it was not possible to trace the sewage by the naked eye, even as far as the commencement of Woodroffe Creek. It is, however, possible—indeed, probable—that after heavy rain the flushing of the sewer might tend to the sewage being visible in the water of the creek for a considerable distance.
>
> The sewage discharged at the second and smaller outfall passes first into a catch-pit, where some of the suspended matter is intercepted, and the remainder discharges at once into a ditch distant about 1 mile from Old Hall Creek, another tributary of Tollesbury Creek.
>
> The only other pollution to be here recorded is at West Mersea, where a drain from some 20 houses discharges on to the foreshore just landward of the "Victory" public-house, and some 43 yards distant from some storage pits belonging to some private oyster merchant. This pollution I consider to be the most serious, from the standpoint of the oysters, of those I have here referred to.

---

* The places whence the samples of water and oysters were derived are shewn in the maps contained in Appendix A.

† The places whence the samples of water and oysters were derived are shewn on maps (Maps No. Iᴀ. and No. 5) accompanying Appendix A.

§ It is not to be inferred that in each instance local conditions have remained unchanged since Dr. Bulstrode's visit.

> * * * * * as regards the River Blackwater west of Thurslett Creek, no sewage discharges into it at a point less than 10 miles distant from the nearest fattening beds of the Tollesbury and Mersea Oyster Company, while some of the sewer outfalls are at a greater distance than this. It will be observed, too, that the fattening beds here referred to are outside the channel of the estuary. Having regard to the circumstance that 11 miles of river intervenes between the Maldon and Heybridge outfalls and the fattening beds in the channel and creeks of the Blackwater, and the fact that the estuary, in the neighbourhood of the fattening beds, is nearly two miles across at high tide, it would appear that danger of sewage pollution of the oysters on these beds cannot be other than very remote. And the same may be said of oysters in pits hereabouts, with the exception of those stored in the pits near the "Victory" at West Mersea, to which I have specially referred."

The oysters obtained in this investigation were from the private layings of Mr. Bean. Mr. Bean has, I understand, re-laid his oysters in the seemingly safe position indicated on the map shewn in this volume. This procedure probably removes the slight element of risk which may have arisen in the past from the fact that a small volume of slop water is discharged into the large volume of water in the Strood Channel in the neighbourhood of where the oysters were previously laid down. Mr. Bean's layings would now seem to come into the category, from the topographical point of view, of one of the purest layings around our coasts for the growth and fattening of oysters.

*ROACH AND CROUCH LAYINGS.**

As regards the Roach and Crouch Rivers, it is necessary to point out that since Dr. Bulstrode's report was written the Crouch oysters have been laid down to fatten at Holliwell Point, that is in a locality far removed from the contaminating influence of the Burnham sewage effluent outfall.§

Liability to sewage pollution in this region is thus described by Dr. Bulstrode on pages 34, 35 and 36 of his report.

Crouch Layings.

> "As regards sewage disposal in the River Crouch, the sewage of Burnham is conducted to certain works situated on the side of the river at a point distant about half a mile eastward of the village. At these works the original intention appears to have been to have subjected the sewage to subsidence and upward filtration through gravel. It seems, however, that the filtering material being of but small extent, frequently became blocked, and in order to facilitate disposal of the sewage the filtration was dispensed with, and the sewage after a very indifferent screening, and a mere apology for subsidence, was led direct to the outfall. At this outfall, situated about a mile distant from Burnham, the sewage is discharged into a small creek leading directly into the Crouch. The sewers of Burnham are, I understand, flushed at least twice weekly, and at these times the "effluent" passing away from the works shows no signs of the effect of subsidence or of any other treatment. I visited these sewage works just after the contents of the flushing tanks had—so I had been informed—been liberated, and found that the "effluent" leaving the works was conspicuously thick and offensive. On walking to the outfall I found the sewage discharged still in the same condition, and that the sides of the creek at low tide were coated for some distance with thick black deposit. On my return I again examined the works, and during the interval the "effluent" had certainly become much clearer. Obviously, however, the treatment to which the sewage of Burnham was being subjected at the time of my visit was of an imperfect character, and for purposes of purification of but little value. * * * * the effluent discharges near to certain private layings, but about 2¼ miles from the fattening beds of the Burnham Oyster Company. This is the main pollution of the River Crouch. Looked at in relation to the whole river, the volume of pollution is perhaps not a very serious matter, but the proximity of the outfall to the private layings referred to would appear compromising to the oysters there situated, while the fattening beds of the Burnham Oyster Company, though, as stated, 2¼ miles eastward of the outfall, cannot be regarded as altogether free from risks of contamination by the Burnham sewage.
>
> The risks to which the storage pits of the Company are liable are but small, as any water taken into them would be received on the flood tide, when the amount of sewage in the river must be quite infinitesimal.
>
> Were this source of pollution removed by the adoption of proper means of purification of the sewage at Burnham sewage works, I should see no reason for regarding the oysters taken from the River Crouch, or from the pits abutting upon it, as otherwise than free from risk of sewage contamination, though obviously no oysters should be laid down close to the outfall of the effluent.

---

* The places whence the samples of water and oysters were derived are shewn in the map (Map No. 2) accompanying Appendix A.

§ The results of the Bacteriological analysis of the Burnham effluent are shewn in Appendix A.

N.B.—I am able to record that, owing to the energetic action of Dr. Thresh, who was one of the first medical officers of health in the country to call attention to the risks of contamination of oysters by sewage, the Maldon Rural District Council have since the date of my visit, taken the steps which Dr. Thresh deemed necessary to purify this effluent."

ROACH LAYINGS.

"The River Roach and the creeks connected with it, such as Yokefleet, Potton and Paglesham, traverse a country which is almost uninhabited, and there can be no question whatever that the majority of the oyster layings hereabouts are practically free from sewage contamination. Over the whole area referred to, the only pollution is that of the effluent from the Rochford sewage. Rochford is a town of about 1,100 inhabitants, the sewage from which is conducted to a settling tank situated just outside its inhabited area. In this tank the sewage is subjected in some degree to sedimentation and screenage, but although probably some good results from this process in times when but little storm water is entering the sewers, it would seem that after heavy rains the whole volume must pass through the tank at such a rate as to afford but little time for any improvement to take place; the "effluent" from the tank discharges to the Roach.

At intervals some carbolic powder is sprinkled on the surface of the liquid in the tanks, and possibly the process may possess some deodorising value; the tank is emptied of its solid contents about twice yearly.

There is room for considerable improvement in the treatment of the Rochford sewage.

It should be pointed out that the outfall of this effluent is a long distance above the point at which any marketable oysters are laid down. I am informed, in fact, that perhaps with one small exception, there are no marketable oysters laid down in the Roach nearer Rochford than East End, over four miles distant from the outfall, while the fattening beds of the Roach River Oyster Company are fully seven miles distant.

Considered generally, the oyster layings in the River Roach and in the numerous creeks connected with it are to be regarded as free from serious risk of sewage contamination; in fact, were steps taken to improve the condition of the Rochford effluent, oysters hereabouts might practically be considered as in this sense secure. Indeed, in a thickly-populated country such as England, it would be difficult to find many more suitable places for oyster culture, from the view point of freedom from pollution, than the creeks abutting upon the Crouch and the Roach Rivers."

PYFLEET LAYINGS.†

As regards the liability of the Pyfleet layings to sewage pollution, Dr. Bulstrode, on page 40 of his report, says:—

Colchester, with a population of 34,559 at the last (1891) census, discharges its effluent into the river, after treatment with lime and sulphate of alumina, at a point 1¾ miles below Colchester East Bridge, where the river is at low tide of but very small dimensions. This is five miles from the nearest oyster layings, and six miles from the mouth of the Pyfleet. The method of sewage treatment at Colchester seemed to be carefully carried out at the time of my visit, and to be such as to reduce enormously the number of organisms originally present in the sewage. At the village of Rowhedge, distant about 1½ miles below the Colchester outfall, are several small drains discharging into the Colne, and at Wivenhoe, a small place about a quarter of a mile seaward of Rowhedge, and on the opposite side of the river, are also other drains discharging on to the foreshore.

At Brightlingsea, with a population considerably over 3,000, the untreated sewage‡ of that place passes into Brightlingsea Creek; but this creek is separated by the whole width of the estuary of the Colne from the Pyfleet, where the Company's fattening beds are situated. Into the Pyfleet itself no drains whatever discharge.

After a careful consideration of all the facts, and taking account of the set of the tides in the Colne, it appears to me that oysters laid down in the Pyfleet or stored in the pits on Peewit Island, are practically free from risk of pollution. Provided, therefore, that all oysters prior to consumption are laid down for a sufficient period on the fattening grounds of the Pyfleet, there is probably no reason to suspect the wholesomeness of Colne Fishery oysters, but it seems to me very undesirable that oysters should be despatched from market direct from the bed of the River Colne.

There are certain layings in Geetong's Creek to the north of the Pyfleet, which belong to a private oyster company, and the same remarks, as regards sewage pollution, would apply to them as to those in the Pyfleet.

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† The places whence the samples of water and oysters were derived are shewn in the map (Map No. 5) accompanying Appendix A.

‡ The conditions are now improved, but an analysis of the tank effluent (Ives patent) yielded very unsatisfactory results (see Appendix A).

Bacteriological Examination of Whitstable, West Mersea, Crouch, Roach and Pyfleet Oysters and Waters.

Speaking in general terms, I think it may be said that the words used by Dr. Bulstrode in describing the Roach and Crouch oyster layings, applies equally to the West Mersea, Whitstable, and Pyfleet layings. He says:—

> "Indeed in a thickly populated country such as England, it would be difficult to find many more suitable places for oyster culture, from the view point of freedom from pollution, than the creeks abutting upon the Crouch and the Roach Rivers."

It is evident from this and the foregoing quotations that Dr. Bulstrode regarded all these layings as reasonably safe for oyster culture on the basis of his topographical observations governed and controlled by his experience as an epidemiologist.

It is necessary to make this point clear, lest the bacteriological facts about to be described be wrongly interpreted. The greatest care has been exercised in this report not to impugn any locality solely on the basis of ascertained bacteriological facts. It were better, perhaps, to disregard the biological data altogether, than to place under the ban of suspicion, localities eminently well suited for the culture of high class oysters, and among the purest practically available around our English shores. Oysters from these layings, despite the bacteriological facts, have seemingly never yet given rise to epidemic disease, and the number of these far-famed oysters consumed annually must indeed be enormous.

It remains, of course, to be seen how far the bacteriological results now to be submitted may, when interpreted in a quantitative as well as a qualitative sense, throw light on the problem.

It will be of advantage, in the first place, to consider the bacteriological condition of the water over these oyster layings.

WHITSTABLE.

B. coli test.

Three out of the four samples contained coli-like microbes in 10 c.c., but not in 1 c.c. One sample contained coli-like microbes in 100 c.c., but not in 10 c.c.

All the samples would have been passed according to the standard of a negative result with 1 c.c.

As regards the biological attributes of the coli-like microbes, all the samples contained completely typical B. coli (on the basis of the tests employed) either in 100 c.c. or 10 c.c..

B. enteritidis sporogenes test.

Three out of the four samples yielded a negative result when 10 c.c. of the water were used for cultural purposes. The remaining sample yielded a positive result with 10 c.c., but a negative result with 1 c.c.

Three out of the four samples would have passed according to the standard of a negative result with 10 c.c.

Remarks.

The results on the whole were satisfactory. It is true that all the samples of water contained B. coli, but in such small proportions that few bacteriologists would press objection to water of this class.

WEST MERSEA.

B. coli test.

The results were seemingly to some extent anomalous. Two samples contained coli-like microbes in 10 c.c.; one sample gave a positive result with 1 c.c., and the remaining sample a positive result with $\frac{1}{10}$ c.c. Thus, two out of the four samples would have been condemned according to the

Division V.

Appendix C.

Bacteriological Examination of Whitstable, West Mersea, Crouch, Roach and Pyfleet Oysters and Waters.

foregoing standard. As regards the biological attributes of the coli-like microbes, all the samples contained microbes indistinguishable as regards the tests employed from the B. coli of the human intestine in 100, 10 or 1 c.c. of the water.

B. enteritidis sporogenes test.

All the samples yielded a negative result with 10 c.c., and therefore all of them passed the tentative standard set up for this test.

Remarks.

It is difficult to pronounce a bacteriological judgment in this case. The fact that, whereas two out of the four samples were objectionable on the B. coli test, none of the four samples were rejected by the B. enteritidis sporogenes test, would suggest that, on the whole, a tentatively favourable opinion should be expressed.

RIVER CROUCH.

B. coli test.

Here again the results were variable. Coli-like microbes were isolated from 100 c.c. in two samples, from 10 c.c. in one sample and from 1 c.c. in the remaining sample. Thus, one out of the four samples was liable to objection. As regards the biological attributes of the coli-like microbes, it may be said that, as regards the tests employed, the micro-organisms on which the above numerical statement is based were indistinguishable from the typical B. coli of the human intestine.

B. enteritidis sporogenes test.

All the samples yielded a negative result when using 10 c.c. for cultural purposes, hence all the samples were passed according to the tentative standard adopted.

RIVER ROACH.

B. coli test

Coli-like microbes were present in two samples in 1 c.c., and in the other two samples in 10 c.c. Thus two out of the four samples were open to objection apart from a consideration of the biological characters of the microbes in question. As regards this point, both of the samples tentatively condemned contained in 1 c.c. microbes which, as regards the tests employed, were indistinguishable from the B. coli of the human intestine.

B. enteritidis sporogenes test.

All four samples yielded a negative result when 10 c.c. were used for cultural purposes. Hence all four samples passed according to the tentative standard adopted.

PYFLEET WATER.

B. coli test.

Coli-like microbes were present in three samples in $\frac{1}{10}$ c.c., and in one sample in 1 c.c. As regards the biological attributes of the coli-like microbes, all the samples contained microbes indistinguishable as regards the tests employed from the B. coli of the human intestine in 1 c.c. or $\frac{1}{10}$ c.c.

B. enteritidis sporogenes test.

One sample yielded a positive result when using, for cultural purposes, 1 c.c. and another sample gave a positive result with 10 c.c. The remaining two samples yielded negative results with 10 c.c.

Thus two out of the four samples were objectionable on the basis of the tentative standard adopted.

Summarising these results, the following tabular statement is of interest:—

Number of coli-like microbes considered independently of their biological attributes.

[Tentative standard, none in 1 c.c.]

—	+ 100 c.c.	+ 10 c.c.	+ 1 c.c.	+ $\frac{1}{10}$ c.c.
Whitstable water - -	1 sample.	3 samples.	—	—
West Mersea water - -	—	2 samples.	1 sample.	1 sample.
Crouch River - - -	2 samples.	1 sample.	1 sample.	—
Roach River - -	—	2 samples.	2 samples.	—
Pyfleet water - - -	—	—	1 sample.	3 samples.

B. enteritidis sporogenes test:—

[Tentative standard, negative result 10 c.c.]

—	Negative 10 c.c.	+ 10 c.c.	+ 1 c.c.
Whitstable water - - - -	3 samples.	1 sample.	—
West Mersea water - - - -	4 samples.	—	—
Crouch River - - - - -	4 samples.	—	—
Roach River - - - - -	4 samples.	—	—
Pyfleet water - - - - -	2 samples.	1 sample.	1 sample.

It is of advantage to summarise the B. coli results according to a method suggested in the Helford and Penryn report (Division IV.) This particular method is based on the arbitrary conception that a coli-like microbe, to be considered typical, must fulfil at least three out of the four positive tests employed in the investigation.* Further, when a sample of water contained say in 1 c.c. coli-like microbes which failed to yield positive results with three out of the four tests the results are divided by ten. But if in such sample the water contained only atypical coli-like microbes in the 10 c.c. culture *also*, then the results are divided by one hundred. That is to say, the gross result as regards coli-like microbes would be + 1 c.c., but the net result in the light of this arbitrary modification would be + 100 c.c.

Number of B. coli based on the foregoing interpretation of the results.

[Tentative standard, none in 1 c.c.]

Water.	+ 100 c.c.	+ 10 c.c.	+ 1 c.c.	+ $\frac{1}{10}$ c.c.
Whitstable - -	3 samples.	1 sample.	—	—
West Mersea - - -	1 sample.	1 sample.	2 samples.	—
Crouch - - -	2 samples.	1 sample.	1 sample.	—
Roach - - - -	1 sample.	1 sample.	2 samples.	—
Pyfleet - - - -	—	—	3 samples.	1 sample.

For the purposes of a broad estimate of how the foregoing tentative standards would affect the question, it may be of advantage to consider all the four experiments from each of the five places together, for the reason that none of these oyster layings would be pronounced by the topographist as other than safe. In other words, the results will be considered in the light of the bacteriological examination of 20 samples of water from one or another pure or reasonably pure locality.

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* Acid clotting of milk cultures; greenish-yellow fluorescence in neutral-red broth cultures; acid and gas in lactose peptone cultures; indol in broth cultures.

Number of coli-like microbes considered independently of their biological attributes.

[Tentative standard, none in 1 c.c.]

+ 100 c.c.	+ 10 c.c.	+ 1 c.c.	+ $\frac{1}{10}$ c.c.
15 per cent.	40 per cent.	25 per cent.	20 per cent.

According to the above tentative standard (none in 1 c.c.), 45 per cent. of the samples would have been objected to, and 55 per cent. would have passed. To lower this standard would, it is feared, inevitably result in the passing of some waters which from the topographist's point of view would be condemned.

Number of B coli based on insistence that the microbes should yield positive results with at least 3 *out of the* 4 *tests* (see *foregoing explanation*) *to be accepted as typical*

+ 100 c.c.	+ 10 c.c.	+ 1 c.c.	+ $\frac{1}{10}$ c.c.
35 per cent.	20 per cent.	40 per cent.	5 per cent.

According to the above standard 45 per cent. of the samples would still be objected to and 55 per cent. be passed.

B. enteritidis sporogenes test.

[Tentative standard, negative result 10 c.c.]

Negative 10 c.c.	+ 10 c.c.	+ 1 c.c.
85 per cent.	10 per cent.	5 per cent.

According to the above standard (negative result 10 c.c.) 15 per cent. of the samples would have been rejected, and 85 per cent. would have passed.

The problem of the bacteriology of the oysters has next to be considered.

WHITSTABLE OYSTERS.

B. coli test.

In one sample the number of coli-like microbes was 100 per oyster. The remaining three samples contained coli-like microbes in the proportion of 10 per oyster.

As regards the biological attributes of the coli-like microbes :—

Sample I. contained, in the last-but-one dilution, microbes indistinguishable on the basis of the tests employed (except as regards the indol test), from the typical B. coli of the human intestine.

In Sample II. the coli-like microbes were completely typical with regard to the tests employed.

As regards Sample III., the coli-like microbes in the last dilution corresponded, in their biological attributes, to those found in Sample I. In the last-but-one dilution the results were, to the tests detailed, in all respects, positive.

Bacteriological Examination of Whitstable, West Mersea, Crouch, Roach and Pyfleet Oysters and Waters.

In respect of Sample IV., a completely typical B. coli (on the basis of the tests employed) was isolated from the last dilution yielding coli-like microbes.

B. enteritidis sporogenes test.

Three samples contained 100 spores of this anaerobe per oyster. The remaining sample contained 10 spores.

The Whitstable oysters seemed, on the basis of this test, to be less pure than the West Mersea, Crouch, Roach, and Pyfleet oysters. Possibly this result may have to do with the discharge of London sewage into the Thames at Barking and Crossness, and London sewage sludge into the Barrow Deep. It is true that the results (*see* Division I. of this Report) show that the bacteriological condition of the Thames at the Chapman Lighthouse, and of the sea water in the Barrow Deep, is, under the circumstances, remarkably satisfactory. Nevertheless, it is conceivable that the resistant spores of this anaerobe persist in the mud of the Thames estuary, and are widespread, remaining as evidence of remote sewage contamination.

WEST MERSEA OYSTERS.

B. coli test.

In one sample the number of coli-like microbes was 1,000; in two samples 100; and in one sample 10 per oyster.

As regards the biological attributes of the coli-like microbes :—

Sample I. contained in the last dilution-but-one microbes indistinguishable (except as regards indol formation) on the basis of the tests employed from the typical B. coli of the human intestine. The coli-like microbes characteristic of the last dilution were less typical.

Sample II. yielded results, similar to Sample I., except that the coli-like microbe characteristic of the last dilution were even more atypical.

As regards Sample III., a microbe indistinguishable, with regard to all the tests, from typical B. coli was isolated from the last dilution.

Sample IV. contained atypical coli-like microbes in the last dilution. In the dilutions next and next-but-one to the last yielding coli-like microbes, some of the bacteria were typical, except as regards indol formation.

In the dilution next-but-two to the last microbes were isolated which could not, on the basis of the tests employed, be distinguished from the typical B. coli of the human intestine. On the whole it would seem as if the coli-like microbes found in the West Mersea oysters were often somewhat atypical in character.

B. enteritidis sporogenes test:

One sample contained 10; the remaining three samples contained less than ten spores of B. enteritidis sporogenes per oyster.

CROUCH OYSTERS.

B. coli test.

One sample contained 1,000; two samples 100; and one sample 10 coli-like microbes per oyster.

As regards the biological attributes of the coli-like microbes :—

Sample IV. contained an apparently completely typical B. coli in the last dilution yielding coli-like microbes.

In all the other samples, the coli-like microbes isolated from the last dilution yielding coli-like microbes failed in more than one respect. Nevertheless, in the case of samples II. and III. apparently completely typical B. coli were isolated from the dilution next to the last yielding coli-like microbes. As regards Sample I., none of the coli-like microbes isolated were seemingly nearly related to typical B. coli.

B. enteritidis sporogenes test.

The results were less satisfactory than in the case of the West Mersea oysters. One sample contained 100, and the remaining three samples 10 spores of B. enteritidis sporogenes per oyster.

ROACH OYSTERS.

B. coli test.

All four samples contained 100 coli-like microbes per oyster.

As regards the biological characters of the coli-like microbes :—

Sample IV. contained completely typical B. coli (on the basis of all the tests) in the last dilution yielding coli-like microbes.

Samples I., II., and III. contained some completely typical B. coli (on the basis of all the tests) in the dilution next to the last yielding coli-like microbes.

B. enteritidis sporogenes test.

Two samples contained 10, and the remaining two samples less than 10 spores of B. enteritidis sporogenes per oyster.

PYFLEET OYSTERS.

B. coli test.

One sample contained 1,000, and the remaining three samples contained 100 coli-like microbes per oyster.

As regards the biological attributes of the coli-like microbes :—Samples I., II., and III., each contained completely typical B. coli, on the basis of the tests employed, in the last dilution, yielding coli-like microbes.

Sample IV. also contained completely typical B. coli, except as regards indol formation, in the last dilution yielding coli-like microbes. From the dilution next to the last microbes were isolated which could not be distinguished, as regards the tests employed, from the typical B. coli of the human intestine.

The coli-like microbes isolated from the Pyfleet oysters were seemingly more often typical of the classical B. coli than the coli-like microbes isolated from the Whitstable, West Mersea, Crouch, and Roach oysters.

B. enteritidis sporogenes test.

Three samples contained 10, and one less than 10 spores of B. enteritidis sporogenes per oyster.

Summarising these results the following tabular statement is of interest :—

Number of coli-like microbes considered independently of their biological attributes :—

[Tentative standards :—less than 1,000 (lenient standard); less than 100 (stringent standard) per oyster.]

——	10 per Oyster.	100 per Oyster.	1,000 per Oyster.
Whitstable oysters - - - -	3 samples.	1 sample.	—
West Mersea oysters - - -	1 sample.	2 samples.	1 sample.
Crouch oysters - - - -	1 sample.	2 samples.	1 sample.
Roach oysters - - - - -	—	4 samples.	—
Pyfleet oysters - - - -	—	3 samples.	1 sample.

B. enteritidis sporogenes test.

[Tentative standards :—less than 100 spores (lenient standard); less than 10 spores (stringent standard) per oyster.]

—	Less than 10 per Oyster.	10 per Oyster.	100 per Oyster.
Whitstable oysters - - - -	—	1 sample.	3 samples.
West Mersea oysters - - -	3 samples.	1 sample.	—
Crouch oysters - - - -	—	3 samples.	1 sample.
Roach oysters - - - - -	2 samples.	2 samples.	—
Pyfleet oysters - - - -	1 sample.	3 samples.	—

It is of advantage to summarise the B. coli results according to a method suggested in the Helford and Penryn report (Division IV.) This method is based on the arbitrary assumption that a coli-like microbe, to be considered typical, must react positively to *at least* three out of the four tests employed in the investigation.* When none of the coli-like microbes representative of the last dilution yielding coli-like microbes fulfil these requirements the numerical B. coli results are divided by ten. Further, if in the dilution next to the last yielding coli-like microbes, none of the microbes isolated gave a positive result with three out of the four tests the initial numerical results are divided by one hundred.

Number of B. coli based on the foregoing interpretation of the results.

[Tentative standards :—less than 1,000 (lenient standard); less than 100 (stringent standard) per oyster.]

—	1 per Oyster	10 per Oyster	100 per Oyster	1,000 per Oyster
Whitstable oysters - -	—	4 samples	—	—
West Mersea oysters - -	—	3 samples	1 sample	—
Crouch oysters - - -	1 sample	2 samples	1 sample	—
Roach oysters - -	—	3 samples	1 sample	—
Pyfleet oysters - - -	—	—	3 samples	1 sample

For the purposes of a broad estimate of how the foregoing tentative standards would affect the question, it may be of advantage to consider together all the four experiments from each of the five places, as none of these oyster layings would be pronounced by the topographist as other than safe. In other words, the results will be considered in the light of the bacteriological examination of 200 oysters in twenty batches of 10 oysters each from one or another pure or reasonably pure laying.

Number of coli-like microbes considered independently of their biological attributes.

1 per Oyster.	10 per Oyster.	100 per Oyster.	1,000 per Oyster.
—	25 per cent.	60 per cent.	15 per cent.

According to the lenient standard (less than 1,000 per oyster) 15 per cent. of the oysters would have been objected to and 85 per cent. would have been passed.

---

* Acid clotting of milk cultures; greenish-yellow fluorescence in neutral-red broth cultures; acid and gas in lactose peptone cultures; indol in broth cultures.

According to the stringent standard (less than 100 per oyster) 75 per cent. of the oysters would have been rejected and 25 per cent. would have been passed.

Number of B. coli based on insistence that the microbes should yield positive results with at least three out of the four tests (see foregoing explanation) to be accepted as typical.

1 per Oyster.	10 per Oyster.	100 per Oyster.	1,000 per Oyster.
5 per cent.	60 per cent.	30 per cent.	5 per cent.

According to the lenient standard (less than 1,000 per oyster), 5 per cent would have been rejected and 95 per cent, would have passed.

According to the stringent standard (less than 100 per oyster) 35 per cent would have been rejected and 65 per cent would have passed.

B. Enteritidis Sporogenes Test.

Less than 10 per Oyster.	10 per Oyster.	100 per Oyster.
30 per cent.	50 per cent.	20 per cent.

According to the lenient standard (less than 100 spores per oyster), 20 per cent. of the oysters would have been rejected and 80 per cent. would have passed.

According to the stringent standard (less than 10 spores per oyster), 70 per cent. of the oysters would have been rejected and 30 per cent. would have passed.

If the Whitstable, West Mersea, Crouch, Roach and Pyfleet layings are to be accepted as pure on topographical grounds,* it is obvious that the adoption of the foregoing stringent standards would be uncalled for. The lenient standards for the B. coli and B. enteritidis sporogenes tests work out fairly in accord with topographical indications, but the question arises whether the application of these lenient standards to oysters derived from layings polluted with *traces* of sewage of *recent* and therefore presumably specially dangerous sort would *always* suffice to bring about rejection of such oysters.

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* It must, of course, be understood that throughout this Report no personal responsibility is incurred for topographical expressions of opinion as regards the purity or otherwise of oyster layings. The rule has been to quote the statements of the highest authority on the subject and for the purposes of comparison with the bacteriological results to accept his *dictum* as if it were final.

TABLE showing the Results of the Bacteriological Examination of Whitstable Oysters (*see* App. A., Map No. 1A.)

TABLE showing the Results of the Bacteriological Examination

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes in 1 c.c.) *per Oyster* (average of ten Oysters.)					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.							
I.	High	10	10	1903	Whitstable oysters, collected 2 miles out, 3 fathoms.			+	–		
						Characters of coli from $\frac{L.D.}{10}$ dilution.					
II.	High	5	11	„	Whitstable oysters, collected 2 miles out, 4 fathoms.		+	–			
						Characters of coli from $\frac{L.D.}{10}$ dilution.					
III.	High	10	11	„	Whitstable oysters, collected 2 miles out.		+	–			
						Characters of coli from $\frac{L.D.}{10}$ dilution.					
IV.	High	17	11	„	Whitstable oysters, gathered in 4 fathoms.		+	–			
						Characters of coli from $\frac{L.D.}{10}$ dilution.					

$\frac{L.D.}{10}$ signifies the last dilution-but-one yielding coli-like microbes.

of Whitstable Oysters (*see* App. A. Map No. 1A).

3. Chief biological characters of the *strain* of B. Coli present in the number specified in Col. 2.						4. B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritis change" in anærobic milk cultures) *per Oyster* (average of 10 Oysters). Cultures heated to 80° C. for 10 minutes.						5.
Gas (Gelatine "shake" cultures, 24 hours at 20° C.).	Indol. (Broth cultures, 5 days at 37° C.).	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.).		Lactose peptone medium + = acid and gas, 48 hours at 37° C.	Neutral-red broth cultures + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	REMARKS.
		(*a*)	(*b*)									
+ N.L.	−	+	−	−	−			+	−			10 oysters = 120 c.c.
+ N.L.	−	+	+	+	+							
(*a*) + N.L.	+	+	+	+	+			+	−			10 oysters = 135 c.c.
(*b*) + N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+							
(*a*) + N.L.	−	+	+	+	+			+	−			10 oysters = 120 c.c.
(*b*) + N.L.	−	+	−	+	+							
(*a*) + N.L.	−	+	+	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	−	+	+							
(*d*) + N.L.	−	+	+	+	+							
(*a*) + N.L.	−	+	−	−	−		+	−				10 oysters = 140 c.c.
(*b*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	−	+	+	+	+							N.B.—Oysters Nos. I., II., III, and IV., correspond with Water Sample Nos. I., II., III., and IV.
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
N.L. signifies no liquefaction, one month.												

TABLE showing the Results of the Bacteriological Examination

1. DESCRIPTION OF THE SAMPLE						2. Number of B. coli (or gas-forming coli-like microbes) in 1 c.c. *per Oyster* (average of ten Oysters).					
No.	Time of Collection.				Other Details.						
	Tide.	Day.	Month.	Year.		1	10	100	1,000	10,000	100,000
I.	2 hours' flood	14	10	1903	West Mersea oysters from Bean's Beds, Mersea Fleet, ½ mile above Inn, opposite Mersea Sailing Club. 200 yards out, 10 feet of water.			+	–		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
II.	High	22	10	,,	Mersea Fleet oysters, 200 yards out, 3 fathoms.			+	–		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
III.	High	24	11	,,	West Mersea oysters, from Bean's Beds, 15 feet of water.		+	–			
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
IV.	Low	27	11	,	West Mersea oysters, from Bean's Beds, 1 fathom, only about 60 yards across channel.				+	–	
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
						Ditto. $\frac{\text{L.D.}}{100}$ dilution.					
						Ditto. $\frac{\text{L.D.}}{1,000}$ dilution.					

$\frac{\text{L.D.}}{10}$ signifies the last dilution-but-one yielding coli-like microbes.

$\frac{\text{L.D.}}{100}$ signifies the last dilution-but-two yielding coli-like microbes.

$\frac{\text{L.D.}}{1,000}$ signifies the last dilution-but-three yielding coli-like microbes.

of West Mersea Oysters (*see* App. A., Map No. 5).

3. Chief biological characters of the *strain* of B. coli present in the number specified in Col. 2.						4. B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritis change" in anærobic milk cultures) *per Oyster* (average of 10 Oysters). Cultures heated to 80° C. for 10 minutes.						5.
Gas. (Gelatine "shake" cultures. 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity, (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.) (*a*)	(*b*)	Lactose peptone medium + = acid and gas, 48 hours at 37° C.	Neutral-red broth cultures + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	**Remarks.**
+ N.L.	–	+	–	+	½+		+	–				10 oysters—160 c.c.
+ N.L.	–	+	+	+	+							
+ N.L.	–	+	–	–	–	Less than 10 per oyster.						10 oysters—130 c.c.
+ N.L.	–	+	+	+	+							
(a) + N.L.	–	+	–	–	(?)+	Less than 10 per oyster.						10 oysters—140 c.c.
(b) + N.L.	+	+	+	+	+							
(a) + N.L.	–	+	–	–	+							
(b) + N.L.	+	+	+	+	+							
(c) + N.L.	–	+	–	–	+							
+ N.L.	–	+	–	–	–	Less than 10 per oyster.						10 oysters—130 c.c.
(a) + N.L.	–	+	+	+	+							
(b) + N.L.	–	+	+	+	+							N.B.—Oyster Nos. I., II., III., and IV., correspond with water sample Nos. I., II., III., and IV.
(c) + N.L.	–	+	–	–	–							
(a) + N.L.	–	+	–	+	–							
(b) + N.L.	–	+	+	+	+							
(c) + N.L.	–	+	–	–	–							
(a) + N.L.	–	+	+	+	+							
(b) + N.L.	+	+	+	+	+							
(c) + N.L.	+	+	+	+	+							
N.L. signifies no liquefaction, one month.												

TABLE showing the Results of the Bacteriological Examination

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. coli (or gas-forming coli-like microbes) in 1 c.c. *per Oyster* (average of ten Oysters).					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.							
I.	High.	8	10	1903.	Crouch oysters gathered opposite Holliwell Point.				+	-	
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
	Flood.	18	11	"	Crouch oysters gathered opposite Holliwell Point 18 ft. of water.		+	-			
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
III.	3 hours ebb.	1	12	"	Crouch oysters gathered off Holliwell Point.			+	-		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
						Ditto $\frac{\text{L.D.}}{100}$ dilution.					
IV.	High.	4	12	"	Crouch oysters gathered opposite Holliwell Point.			+	-		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
						Ditto $\frac{\text{L.D.}}{100}$ dilution.					

$\frac{\text{L.D.}}{10}$ signifies the last dilution-but-one yielding coli-like microbes.

$\frac{\text{L.D.}}{100}$ signifies the last dilution-but-two yielding coli-like microbes.

of Crouch Oysters (*see* App. A., Map No. 4).

3.						4.						5.
Chief Biological Characters of the *strain* of B. Coli present in the number specified in col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures) *per Oyster* avera. e of 10 Oysters). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus Milk cultures 5 days at 37° C.)		Lactose Peptone medium + = acid and gas, 48 hours at 37° C.	Neutral red broth + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1000	10,000	100,000	
		(*a*)	(*b*)									
+ N.L.	–	+	–	–	–			+	–			10 oysters = 110 c.c.
+ N.L.	–	+	+?	–	+							
(*a*) + N.L.	–	+	–	–	–		+	–				10 oysters = 120 c.c.
(*b*) + N.L.	–	+	–	–	+							
(*c*) + N.L.	–	+	–	+	+							
(*a*) + N.L.	+	+	+	+	+							
(*b*) + N.L.	–	+	–	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	–	+	–	–	+?		+	–				10 oysters = 130 c. c.
(*b*) + N.L.	–	+	–	Acid, slight gas.	–							
(*a*) + N.L.	+	+	+	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	+	+	+	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	–	+	+	+	+?		+	–				10 oysters = 120 c..c.
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	–	+	–	–	+							
(*a*) + N.L.	+	+	+	+	+							N.B.—Nos. I, II, III, and IV correspond with water numbers I., II., III. and IV.
(*b*) + N.L.	–	+	+	+	+							
(*a*) + N.L.	–	+	+	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
N.L. signifies no liquefaction one month.												

TABLE showing the Results of the Bacteriological

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c. *per Oyster* (average of ten Oysters.)					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.							
I.	Flood	9	10	1903.	Roach Oysters, 50 feet of water (*see* App. A., Map 4).			+	−		
						Character of coli from $\frac{\text{L.D.}}{10}$ dilution.					
II.	Flood	18	11	„	Roach Oysters, 40 feet of water (*see* App. A., Map 4).			+	−		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
						Ditto, $\frac{\text{L.D.}}{100}$ dilution.					
III.	1 hour ebb.	1	12		Roach Oysters (*see* App. A., Map 4).			+	−		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
						Ditto $\frac{\text{L.D.}}{100}$ dilution.					
IV.	4 hours' flood.	4	12	„	Roach Oysters (*see* App. A., Map 4).			+	−		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
						Ditto, $\frac{\text{L.D.}}{100}$ dilution.					

$\frac{\text{L.D.}}{10}$ signifies the last dilution-but-one yielding coli-like microbes.

$\frac{\text{L.D.}}{100}$ signifies the last dilution-but-two yielding coli-like microbes.

Examination of Roach Oysters (*see* App. A., Map 4).

3.						4.						5.
Chief Biological Characters of the *strain* of B. coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures) *per Oyster* (average of 10 Oysters). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas (Gelatine "shake" cultures, 24 hours to 20° C.)	Indol (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium + = acid and gas, 48 hours at 37° C.	Neutral-red broth cultures, + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)									
+ N.L.	–	+	+ (?)	–	+		+	–				10 oysters = 120 c.c.
+ N.L.	+	+	+	+	+							
(*a*) + N.L.	–	+	–	–	–		+	–				10 oysters = 110 c.c.
(*b*) + N.L.	–	+	–	–	–							
(*a*) + N.L.	+		+	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	+	+	+	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	–	+	–	–	+							
(*a*) + N.L.	–	+	–	–	+		Less than 10 per oyster.					10 oysters = 120 c.c.
(*b*) + N.L.	–	+	–	–	+							
(*a*) + N.L.	+	+	–	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	+	+	+	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	+	+	+	+	+		Less than 10 per oyster.					10 oysters = 105 c.c.
(*b*) + N.L	–	+	–	–	+							
(*a*) + N.L.	–	+	+	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	–	+	–	–	+							
(*a*) + N.L.	+	+	+	+	+							N.B.—Nos. I., II., III., and IV. correspond with Water Samples Nos. I., II., III., and IV.
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
N.L. signifies no liquefaction, one month.												

TABLE showing the Results of the Bacteriological Examination

1.						2.					
DESCRIPTION OF THE SAMPLE.						Number of B. coli (or gas-forming coli-like microbes) in 1 c.c. *per Oyster* (average of 10 Oysters).					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.							
I.	Low.	13	10	1903.	Pyfleet oysters, gathered opposite packing house, water 3¼ fathoms.				+	−	
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
II.	High.	21	10	,,	Pyfleet oysters, gathered same place as No. I. 26 feet of water.			+	−		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
III.	High.	2	12	,,	Pyfleet oysters, gathered same place as No. I.			+	−		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
						Ditto, $\frac{\text{L.D.}}{100}$ dilution.					
IV.	3 hours' ebb.	4	12	,,	Pyfleet oysters, gathered at same place as No. I.			+	−		
						Characters of coli from $\frac{\text{L.D.}}{10}$ dilution.					
						Ditto, $\frac{\text{L.D.}}{100}$ dilution.					

$\frac{\text{L.D.}}{10}$ signifies the last dilution but one yielding coli-like microbes.

$\frac{\text{L.D.}}{100}$ signifies the last dilution but two yielding coli-like microbes.

of Pyfleet Oysters (*see* App. A., Map 5.)

3.						4.						5.
Chief Biological Characters of the *strain* of B.Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures) *per Oyster* (average of 10 Oysters). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium + = acid and gas 48 hours at 37° C.	Neutral-red Broth. + = greenish-yellow flouorescence 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)									
+ N.L.	+	+	+	+	+		+	–				10 oysters = 160 c.c.
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+		Less than 10 per oyster.					10 oysters = 150 c c
+ N.L.	+	+	+	+	+							
(*a*) + N.L.	+	+	+	+	+		+	–				10 oysters = 135 c.c
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	–	+	+	Acid, and slight gas.	+							
(*a*) + N.L.	+	+	+	+	+							
(*b*) + N.L.	–	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	+	+	+	+	+							
(*b*) + N.L.	–	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	–	+	–	Acid,slight gas.	+		+	–				10 oysters = 120 c.c.
(*b*) + N.L.	–	+	+	+	+							
(*a*) + N.L.	–	+	–	+	+							
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
(*a*) + N.L.	+	+	+	+	+							N.B. Nos. I., II., III., and IV. correspond with with the water samples Nos. I., II., III., and IV.,
(*b*) + N.L.	+	+	+	+	+							
(*c*) + N.L.	+	+	+	+	+							
N.L. signifies no liquefaction, one month.												

TABLE showing the Results of the Bacteriological Examination of Samples

1.						2.							
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.							
No.	Time of Collection.				Other Details.	+ 100 c.c.	+ 10 c.c.	1 — 1 c.c.	10 — ·1 c.c.	100 — ·01 c.c.	1,000 — ·001 c.c.	10,000 — ·0001 c.c.	100,000 — ·00001 c.c.
	Tide.	Day.	Month.	Year.									
I.	Flood	10	10	1903	Water from Whitstable collected 2 miles out, 3 fathoms of water parallel to coast line		+	– Characters of the coli from the 100 c.c. culture.					
II.	Flood	5	11	,,	Water from Whitstable collected 2 miles out.		+	– Characters of coli from the 100 c.c. culture.					
III.	Flood	10	11	,,	Water from Whitstable collected 2 miles out.	+	–						
IV.	Flood	17	11	,,	Water from Whitstable collected 2 miles out, 24 ft. of water.		+	Characters of coli from the 100 c.c. culture.					
I.	2 hrs. Flood	14	10	1903	Water from West Mersea over Bean's layings, Mersea Fleet, 10 ft. of water.			Characters of coli from the 1 c.c. culture. Characters of coli from the 10 c.c. culture.	+	–			
II.	Flood	22	10	,,	Water from West Mersea Fleet. 200 yards out, 3 fathoms.			+ Characters of coli from the 10 c.c. culture.	–				
III.	High	24	11	,,	Water from West Mersea over Bean's layings, 15 ft. of water.		+	– Characters of coli from the 100 c.c. culture.					
IV.	Low	27	11	,,	Water from West Mersea over Bean's layings, 6 ft. of water, and only about 60 yds. across.		+	– Characters of coli from the 100 c.c. culture.					

of Whitstable and West Mersea Waters (*see* App. A., Map 1A and 5).

3.						4.						5.
Chief Biological Characters of the *Strain* of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.) (*a*)	(*b*)	Lactose peptone medium + = acid and gas, 48 hours at 37° C.	Neutral-red Broth. + = greenish-yellow fluorescence, 48 hours at 37° C.	1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.	
+N.L.	–	+	+	–	+	–		(Positive 10 c.c.)				Nos. I., II., III. and IV. correspond with oyster Nos. I., II., III., and IV.
+N.L.	+	+	+	+	+							
(*a*) +N.L.	–	+		acid, slight gas	+			Negative 10 c.c.				
(*b*) +N.L.	–	+	–	–	+							
+ N.L.	+	+	+	+	+							
(*a*) +N.L.	+	+	+	+	+			Negative 10 c.c.				
(*b*) +N.L.	–	+	–	acid and slight gas	+							
(*a*) + N.L.	+	+	+	+	+			Negative 10 c.c.				
(*b*) + N.L.	–	+	–	+	+							
(*c*) + N.L.	–	+	–	–	½ –							
+ N.L.	+	+	+	+	+							
+N.L.	–	+	–	+	–			Negative 10 c.c.				Nos. I., II., III. and IV. correspond with oyster Nos. I., II., III., and IV.
+N.L.	+	+	+	+	+							
+N.L.	+	+	+	+	+							
+N.L.	+	+	+	+	+			Negative 10 c.c.				
+N L.	–	+	+	+	+							
+ N.L.	+	+	+	+	+			Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
(*a*) + N.L.	–	+	–	–	–			Negative 10 c.c.				
(*b*) + N.L.	–	–	–	–	–							
+ N.L.	+	+	+	+	+							

Note.—N.L. signifies no liquefaction 1 month.

TABLE showing the Results of the Bacteriological Examination of Samples

1.						2.							
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.							
No.	Time of Collection.				Other Details.			1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.		+ 100 c.c.	+ 10 c.c.	1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
I.	High	8	10	1903	Water from the mouth of the Crouch River.	+	−						
II.	Flood	18	11	,,	Water from the Crouch River, opposite Holliwell Point, 18 feet of water	+	−						
III.	3 hours' ebb	1	12	,,	Water from the Crouch River, off Holliwell			+	−				
						Characters of the coli from the 10 c.c. culture							
						Ditto, from the 100 c.c. culture							
IV.	High	4	12	,,	Water from the Crouch River, opposite Holliwell Point		+	−					
						Characters of the coli from the 100 c.c. culture							
I.	Flood	8	10	1903	Water from the Roach River, 2 feet down, 50 feet of water		+	−					
						Characters of the coli from the 100 c.c. culture							
II.	Flood	18	11	,,	Water from the Roach River, 40 feet of water		+	−					
						Characters of the coli from the 100 c.c. culture							
III.	1 hour's ebb.	1	12	,,	Water from the Roach River			+	−				
						Characters of the coli from the 10 c.c. culture							
						Ditto, from 100 c.c. culture							
IV.	4 hours' flood	4	,,	,,	Water from the Roach River			+	—				
						Characters of the coli from the 10 c.c. culture							
						Characters of the coli from the 100 c.c. culture							

of Crouch and Roach Waters (*see* App. A., Map 4).

3						4						5.
Chief Biological Characters of the *strain* of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk culture, 5 days at 37° C.)		Lactose peptone medium. + = acid and gas, 48 hours at 37° C.	Neutral-red Broth. + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)			1 c.c.	·1 c.c.	·01 cc.	·001 c.c.	·0001 c.c.	·0001 c.c.	
+ N.L.	+	+	+	+	+			(Negative 10 c.c.)				
+ N.L.	+	+	+	+	+			(Negative 10 c.c.)				
(*a*) + N.L	+	+	+	+	+			(Negative 10 c.c.)				
(*b*) + N.L	+	+	+	+	+							
(*c*) + N.L	—	+	—	—	+							
(*a*) + N.L	+	+	+	+	+							Nos. I., II., III., and IV. correspond with Oyster Nos. I., II., III., and IV.
(*b*) + N.L	+	+	+	+	+							
+ N.L.	+	+	+	+	+							
(*a*) + N.L	+	+	+	+	+			(Negative 10 c.c.)				
(*b*) + N.L	—	+	—	—	+							
+ N.L.	+	+	+	+	+							
N.L. signifies no liquefaction, one month												
+ N.L.	–	+	–	+	+			(Negative 10 c.c.)				
+ N.L.	+	+	–	(?) Acid gas	+							
(*a*) + N.L	—	+	–	+	+			(Negative 10 c.c.)				
(*b*) + N.L	+	+	+	+	+							
+ N.L.	+	+	+	+	+							
+ N.L.	+	+	+	+	+			(Negative 10 c.c.)				
(*a*) + N.L	+	+	+	+	+							
(*b*) + N.L	+	+	+	+	+							
(*c*) + N.L	+	+	+	+	+							
+ N.L.	+	+	+	+	+							Nos. I., II., III., and IV. correspond with Oyster Nos. I., II., III., and IV.
(*a*) + N.L	–	+	–	Acid sl. gas	+			(Negative 10 c.c.)				
(*b*) + N.L	–	+	–	Acid sl. gas	+							
(*c*) + N.L	+	+	+	+	+							
(*a*) + N.L	+	+	+	+	+							
(*b*) + N.L	+	+	+	+	+							
(*c*) + N.L	+	+	+	+	+							
+ N.L.	+	+	+	+	+							
N.L. signifies no liquefaction, of gelatine one month												

Table showing the Results of the Bacteriological Examination of Samples

1						2.							
DESCRIPTION OF THE SAMPLE.						Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.							
No.	Time of Collection.				Other Details.	+100 c.c.	+10 c.c.	1	10	100	1,000	10,000	100,000
	Tide.	Day.	Month.	Year.				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
I.	Low	13	10	1903	Water from Pyfleet, collected opposite packing house; depth 3¼ fathoms.				+	−			
						Characters of coli from the 1 c.c. culture							
II.	High	21	10	,,	Water from Pyfleet, collected at same place as No. 1. 26 feet of water.				+	−			
						Characters of coli from the 1 c.c. culture							
III.	High	2	12	,,	Water from Pyfleet, collected at same place as No. 1.				+	−			
						Characters of coli from the 1 c.c. culture							
						Characters of coli from the 10 c.c. culture							
						Characters of coli from the 100 c.c. culture							
IV.	3 hours ebb.	4	12	,,	Water from Pyfleet, collected at same place as No. 1.			+	−				
						Characters of coli from the 10 c.c. culture							
						Characters of coli from the 100 c.c. culture							

of Pyfleet Waters (*see* App. A., Map. 5).

3.						4.						
Chief Biological Characters of the *strain* of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose-peptone medium + = acid and gas, 48 hours at 37° C.	Neutral-red broth + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+ N. L.	-	+	–	–	½ +			(Positive 10 c.c.)				
+ N. L.	+	+	+	+	+							
+ N. L.	–	+	–	–	¾ +			Negative 10 c.c.				
+ N. L.	+	+	+	+	+							
+ N. L.	+	+	+	+	+							Nos. I., II., III. and IV. correspond with oyster Nos. I., II., III. and IV.
(*a*) + N. L.	+	+	+	+	+			Negative 10 c.c.				
(*b*) + N. L.	+	+	+	+	+							
(*a*) + N. L.	+	+	+	+	+							
(*b*) + N. L.	+	+	+	+	+							
(*c*) + N. L.	+	+	+	+	+							
+ N. L.	+	+	+	+	+							
(*a*) + N. L.	+	+	+	+	+	+	–					
(*b*) + N. L.	+	+	+	+	+							
(*c*) + N. L.	+	+	+	+	+							
(*a*) + N. L.	–	+	–	+	+							
(*b*) + N. L.	+	+	+	+	+							
(*c*) + N. L.	–	+	+	+	+							
+ N. L.	+	+	+	+	+							

N. L. signifies no liquefaction one month.

APPENDIX D.

Experiments showing that B. coli or coli-like microbes can not only be practically always isolated from a *mixture* of ten oysters (Appendix C) derived from layings which, judged from the topographical point of view, would be considered either above suspicion or at least reasonably secure from pollution; but also that such microbes can usually be isolated from each *individual*, or, at all events, from a great majority of the ten oysters experimentally tested.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, and Roach and Pyfleet layings.

Helford Oysters.

Experiment I.—(Helford Oysters.)

Ten oysters collected in the Helford River, at low tide on October 12th, 1903, were washed in the manner described elsewhere, opened with a sterile knife and, while remaining within their concave shells, separately cut up with sterile scissors. 1 c.c. of the liquid thus liberated was in each instance added with a sterile pipette to a tube containing sterile bile salt broth. A second c.c. of oyster liquid was added to a tube containing 9 c.c. of sterile distilled water, in order to obtain dilution (1) (1 c.c. of which is equal to $\frac{1}{10}$ c.c. of oyster liquid); from dilution (1), 1 c.c. was withdrawn and added to a second tube containing 9 c.c. of sterile water, thus making dilution (2); and from dilution (2), 1 c.c. was withdrawn and added to a third tube containing 9 c.c. of sterile water, thus making dilution (3). 1 c.c. of dilution (1) was therefore equivalent to 0·1 c.c. of oyster liquid; 1 c.c. of dilution (2) to 0·01 c.c. of oyster liquid, and 1 c.c. of dilution (3) to 0·001 c.c. of oyster liquid. From dilutions (1), (2), (3), respectively, 1 c.c. was withdrawn and added, in each instance, to a tube containing sterile bile salt broth.

From the primary cultures made in this manner, coli-like microbes were isolated by the gelatine plate method, from each of the ten oysters. The microbes exhibited in pure culture the following characters:—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures.	Lactose peptone cultures.	*Neutral-red broth cultures.	Broth cultures.	Litmus Milk cultures.
A	0·1	Gas	Acid and gas	Positive	Indol	Acid and Clot
	0·01	Gas	Acid and gas	Positive	Indol	Acid and Clot
B	0·1	Gas	Acid and gas	Positive	No indol	Acid and Clot
	0·01	Gas	Acid and gas	Positive	Indol	Acid and Clot
C	1·0	Gas	Acid and gas	Positive	Indol	Acid and Clot
	0·1	Gas	Acid and gas	Positive	Indol	Acid and Clot
D	0.1	Gas	Acid and gas	Positive	Indol	Acid, no Clot
	0·01	Gas	Acid and gas	Positive	Indol	Acid and Clot
E	0·1	Gas	Acid and gas	Positive	Indol	Acid and Clot
	0·01	Gas	Acid, slight gas	Negative	No indol	Acid, slight Clot
F	1·0	Gas	Acid and gas	½ positive	Indol	Acid and Clot
	0·1	Gas	Acid and gas	Positive	Indol	Acid and Clot
G	0·1	Gas	Acid and gas	Positive	Indol	Acid and Clot
	0·01	Gas	No acid, no gas	Negative	No indol	Acid no Clot
H	0·1	Gas	No acid, no gas	Positive	No indol	Acid no Clot
	0·01	Gas	Acid and gas	Positive	Indol	Acid and Clot
I	1·0	Gas	Acid and gas	Positive	Indol	Acid and Clot
	0·1	Gas	No acid, no gas	Negative	No indol	Acid and Clot
J	0·1	Gas	Acid and gas	Positive	Indol	Acid and Clot
	0·01	Gas	Acid and gas	Positive	Indol	Acid and Clot

* "Positive" indicates that the growth of the microbe produced a greenish yellow fluorescence in the medium. "Negative" indicates that this change did not occur.

Division V.

Appendix D.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

It will be seen from the foregoing table that of the oysters thus tested seven (70 per cent.) contained coli-like microbes in 0·01 c.c. (corresponding to 100 coli-like microbes per c.c.), and three (30 per cent.) in 0·1 c.c. (10 coli-like microbes per c.c.). None of the coli-like microbes liquefied gelatine within one month.

Further, 50 per cent. of these oysters contained in 0·01 c.c. ($\frac{1}{100}$ c.c.), 40 per cent. in 0·1 c.c. ($\frac{1}{10}$ c.c.) and 10 per cent. in 1 c.c. microbes apparently indistinguishable by the tests employed from the typical B. coli of the human intestine. *Thus it will be seen that a microbe apparently indistinguishable from the typical B. coli of the human intestine was obtained from each of the ten oysters* (100 *per cent.*) *of experiment.*

Since the Helford layings are, from the topographical point of view, to be considered above suspicion, doubt is admissible, judging from the results of this experiment, whether, with regard to individual oysters derived from layings contiguous to English shores, the majority do not contain B. coli, or gas-forming coli-like microbes.

Whitstable Oysters.

EXPERIMENT II. (Whitstable Oysters).

Ten oysters collected at Whitstable, November 17th 1903, were each subjected to a quantitative and qualitative examination in the manner described in the foregoing experiment. From each oyster one or more non-liquefying varieties of coli-like microbes were isolated.

The microbes displayed in pure culture the following characters :—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures.	Lactose peptone cultures.	* Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	1 c.c.	Gas	Acid and gas	Positive	No indol	Acid and clot
B	1 c.c.	Gas	Acid and gas	Positive	No indol	Acid, no clot
C	1 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
D	1 c.c.	Gas	Acid and gas	(?) Positive	No indol	Acid, no clot
	0·1 c.c.	Gas	Acid, slight gas	Positive	No indol	Acid, no clot
E	1 c.c.	Gas	Acid and gas	Positive	No indol	Acid, no clot
	0·1 c.c.	Gas	Acid and gas	½ positive	No indol	Acid, no clot
F	1 c.c.	Gas	No acid, no gas	Negative	No indol	Acid, no clot
	0·1 c.c.	Gas	Acid and gas	Negative	No indol	Acid, no clot
G	1 c.c.	Gas	No acid, no gas	½ positive	No indol	Alkali
H	1 c.c.	Gas	Acid, slight gas	½ negative	No indol	Acid, no clot
I	1 c.c.	Gas	Acid and gas	Positive	No indol	Acid, no clot
	0·1 c.c.	Gas	Acid and gas	½ positive	No indol	Acid, no clot
J	1 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
	0·1 c.c.	Gas	Acid and gas	½ positive	No indol	Acid, slight clot

* "Positive" indicates that the growth of the microbe produced a greenish-yellow fluorescence in the medium ; "negative" indicates that this change did not occur.

Bacteriological Examination of individual oysters obained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

It will be seen from the foregoing table that 50 per cent. of these Whitstable oysters contained coli-like microbes in 0·1 c.c. (*i.e.*, 10 coli-like microbes per c.c. of oyster liquid): the remaining 50 per cent. of these oysters contained coli-like microbes in 1 c.c.; *i.e.*, one coli-like microbe per c.c. of oyster liquid. Hence all the oysters (100 per cent.) contained coli-like microbes.

Scrutiny of the table will show that the microbes isolated from 1 c.c. of oysters C and J respectively, were, with regard to the tests there detailed, indistinguishable from the typical B. coli of the human intestine.

It is worth noting that no less than 90 per cent. of the oysters contained coli-like microbes which yielded acid and gas in lactose peptone medium. Further, 70 per cent. of the oysters contained coli-like microbes which gave a *completely* positive result with the neutral-red broth test.

Moreover, it will be seen by reference to Appendix C, that the Whitstable oysters examined in the routine manner frequently contained either completely typical or almost typical B. coli. *See* also Series of Experiments, to ascertain whether B. coli is present in the stomach contents of oysters (Appendix H).

Under these circumstances, it was thought desirable to repeat the experiment with certain modifications. It was anticipated indeed that failure to isolate completely typical B. coli from a majority of the oysters in the foregoing experiment was merely due to the amount of material used being insufficient.

EXPERIMENT III. (Whitstable Oysters).

Ten oysters collected at Whitstable, December 11th 1903, were severally treated as follows:—

Each oyster, after cleansing its exterior in the usual manner, was opened with the customary precautions, and cut up in the concave shell with sterile scissors. With a sterile pipette, as much of the liquid as could possibly be obtained was in each instance transferred to a bile salt broth tube; the rest of the contents of the concave shell being conveyed with suitable precautions to a wide-mouthed tube containing 50 c.c. of bile salt broth. The amount used in each case for cultural purposes, and the results of the subcultural tests are set forth in the following table.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures. (+ = gas.)	Lactose Peptone cultures.	* Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	7 c.c.	+	Acid and gas	Positive	Indol	Acid and clot
	Rest of oyster	+	Acid and gas	Positive	Indol	Acid and clot
B	6 c.c.	+	Acid and gas	Positive	Indol	Acid and clot
	Rest of oyster	+	Acid and gas	Negative	No indol	Acid and clot
C	7 c.c.	+	Acid and gas	Positive	Indol	Acid and clot
	Rest of oyster	+	Acid v. sl. gas	Positive	No indol	Acid and clot
D	4 c.c.	+	Negative	Positive	No indol	Acid, no clot
	Rest of oyster	+	Acid and gas	Positive	No indol	Acid, slight clot
E	5 c.c.	+	Acid and gas	Positive	Indol	Acid and clot
	Rest of oyster	+	Acid and gas	Positive	Indol	Acid and clot
F	5 c.c.	+	Acid and gas	Positive	Indol	Acid and clot
	Rest of oyster	+	Negative	Negative	No indol	Acid and clot (atypical)
G	6 c.c.	+	Acid and gas	Positive	Indol	Acid and clot
	Rest of oyster	+	Negative	(?) Negative	No indol	Acid, no clot
H	1 c.c.	+	Acid and gas	Negative	No indol	Acid and clot
	Rest of oyster	+	Negative	(?) Negative	No indol	Acid and clot (atypical)
I	6 c.c.	+	Acid and gas	Positive	Indol	Acid and clot
	Rest of oyster	+	Acid and gas	Positive	No indol	Acid and clot
J	5 c.c.	+	Acid and gas	Positive	Indol	Acid and clot
	Rest of oyster	+	Acid and gas	Positive	Indol	Acid and clot

* "Positive" indicates greenish-yellow fluorescence. "Negative" indicates that this change did not occur.

It is apparent that 100 per cent. of the oysters contained coli-like microbes. None of the microbes isolated were found to liquefy gelatine.

As regards the biological attributes of the coli-like microbes :—

100 per cent. gave acid and gas in one or other of the lactose-peptone cultures.

90 per cent. produced greenish-yellow fluorescence in one or other of the neutral-red broth cultures.

80 per cent. produced indol in one or other of the broth cultures.

90 per cent. produced acid clotting of milk in one or other of the litmus milk cultures.

Hence : *No less than 80 per cent. of the oysters contained microbes indistinguishable on the basis of the tests employed from the classical B. coli of the human intestine.*

Division V.

Appendix D.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

West Mersea Oysters.

EXPERIMENT IV. (West Mersea Oysters.)

On 25th November 1903, ten oysters obtained from West Mersea were dealt with in the quantitative and qualitative manner described in detail in the account of the first experiment of this series.

From nine of the ten oysters (90 %) coli-like microbes were isolated in pure culture. The coli-like microbes thus obtained exhibited the following cultural characters :—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures.	Lactose peptone cultures.	*Neutral red broth cultures.	Broth cultures.	Litmus milk cultures.
A	1 c c.	No coli-like microbes could be found.				
	0.1 c.c	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
B	1 c.c.	Gas.	No acid, no gas.	Negative.	No indol.	Acid, no clot.
C	1 c.c.	Gas.	No acid, no gas.	Negative.	No indol.	No acid, no clot.
D	1 c.c.	No coli-like microbes could be found.				
E	1 c.c.	No coli-like microbes could be found.				
	0·1 c.c.	Gas.	No acid, no gas.	Negative.	No indol.	No acid, no clot.
F	1 c.c.	No coli-like microbes could be found.				
	0·1 c.c.	Gas.	No acid, no gas.	Negative.	No indol.	Acid, no clot.
G	1 c.c.	Gas.	No acid, no gas.	Negative.	No indol.	Acid, no clot.
H	1 c.c.	Gas.	No acid, no gas.	Negative.	No indol.	No acid, no clot.
	0·1 c.c.	Gas.†	Acid, no gas.	Negative.	Indol.	No acid, no clot.
I	1 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
J	1 c.c.	Gas.	Acid, no gas.	Negative.	No Indol.	Acid, slight clot.

* "Positive" indicates production of greenish-yellow fluorescence in neutral-red broth. "Negative" indicates that this change did not occur.

† This microbe produced a slight softening of the gelatine. None of the other microbes liquefied gelatine within one month.

As regards typical B. coli, this experiment is notable chiefly in its negative aspects. Only two (20 per cent.) of the oysters yielded microbes which, when isolated in pure culture, produced in the lactose-peptone medium both acid and gas; other two oysters (20 per cent.) yielded microbes, which under comparable conditions produced acid only in this medium; the remaining microbes isolated from the oysters of experiment produced no change in this medium. Similarly, only three oysters (30 per cent.) yielded microbes forming indol in broth cultures, and only two oysters A and I (20 per cent.) yielded microbes producing in neutral-red broth the greenish-yellow fluorescence similar to that produced by typical B. coli; only three oysters (30 per cent.) yielded microbes capable of producing acidity and clotting in litmus milk cultures, while three other oysters (30 per cent.) yielded microbes which were capable of forming acid in, but lacked the power to clot milk. The remaining microbes isolated, failed to react in a positive manner with regard to production of acidity and clotting in milk.

The point of interest, therefore, in this experiment is that, though the majority of gas-forming coli-like microbes isolated exhibited a more or less remote resemblance to B. coli, only 20 per cent. of the oysters yielded microbes indistinguishable by the tests detailed from typical B. coli derived directly from the human body. Similar experience was encountered in the examination of the West Mersea oysters by the routine method (Appendix C.).

EXPERIMENT V.—(West Mersea Oysters).

On 28th November 1903, ten West Mersea oysters were dealt with in the manner described in detail in the account of the first experiment of this series, with regard to the manner of preparing and opening the oysters, and cutting up in their shells the bodies of the oysters. A sterile pipette was in each instance used to transfer as many c.c. as were obtainable of the liquid thus liberated to a tube containing sterile bile salt broth. The object of this modification was to discover whether or not the atypical characters of the coli-like microbes isolated in Experiment IV. were due either to accident or to degree (*i.e.*, amount of material subcultured) or to both these factors combined. From each of the ten oysters (100 per cent.) a *non-liquefying* coli-like microbe was isolated in pure culture by the gelatine plate method. The coli-like microbes obtained reacted to certain tests as follows:—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures.	Lactose peptone cultures.	*Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	4 c.c.	Gas	Acid and gas.	Positive.	No indol.	Acid and clot.
B	4 c.c.	Gas	Acid and gas.	Negative.	No indol.	Acid, no clot.
C	4 c.c.	Gas	Acid and gas.	Positive.	Indol.	Acid and clot.
D	3 c.c.	Gas	Bleached and gas.	Positive.	Indol.	Acid and clot.
E	3 c.c.	Gas	Bleached, very slight gas.	Positive.	No indol.	Acid, no clot.
F	5 c.c.	Gas	Acid and gas.	Positive.	No indol.	Acid, no clot.
G	4 c.c.	Gas	Acid and gas.	Negative.	Indol.	Acid and clot.
H	5 c.c.	Gas	Acid and gas.	Positive.	No indol.	Acid, no clot.
I	6 c.c.	Gas	Acid and gas.	Positive.	No indol.	Acid and clot.
J	6 c.c.	Gas	Acid and gas.	Positive.	No indol.	Acid and clot.

* "Positive" indicates the production of greenish yellow fluorescence in this medium "Negative" indicates that this change did not occur.

It will be seen from the foregoing table that two of the oysters (20 per cent.) yielded microbes which, by the tests detailed, were indistinguishable

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable West Mersea, Crouch, Roach and Pyfleet layings.

from the typical B. coli of the human intestine. It is further interesting to note that 30 per cent. of the oysters (oysters A, I, J) yielded microbes closely resembling B. coli and behaving in a manner exactly similar to the classic microbe to all the tests employed, the indol test alone excepted. From oyster G, the microbe isolated failed only with respect to the neutral-red broth test. The microbes isolated respectively from oysters B, E, F, H (40 per cent.), failed in response to the detailed tests in two or more respects. It is noteworthy that not one of the microbes isolated failed to form gas with the lactose peptone test.

It would seem from the results of this experiment that the atypical characters of the coli-like microbes observed in the previous experiment (IV.) were due largely either to accident or to degree (*i.e.*, amount of material subcultured), or both these factors combined, and was not wholly an intrinsic property of the West Mersea oysters.

An additional experiment was undertaken with the object of elucidating this problem.

EXPERIMENT VI. (West Mersea Oysters.)

This experiment with the West Mersea oysters gathered on December 14th 1903, was in all respects comparable with Experiment III. (Whitstable oysters).

The amount withdrawn in each case for cultural purposes and the results of the subcultural tests are set forth in the following table :—

Oyster.	Amount of oyster in c.c.	Gelatine "shake" cultures. (+=gas)	Lactose peptone cultures.	*Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	4 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
B	5 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Negative.	Positive.	No indol.	Acid, no clot.
C	5 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
D	5 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
E	9 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
F	5 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
G	8 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
H	7 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Negative.	Positive.	No indol.	Acid, no clot.
I	7 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Acid, no gas.	Positive.	No indol.	Acid, no clot.
J	5 c.c.	+	Acid and gas.	Positive.	Indol.	Acid and clot.
	Rest of oyster.	+	Acid and gas.	Positive.	Indol.	Acid and clot.

* "Positive" indicates the production of greenish-yellow fluorescence in this medium. "Negative" indicates that this change did not occur.

It will be noted that 100 per cent. of the oysters contained coli-like microbes and that none of the isolated microbes were found to liquefy gelatine.

As regards the biological attributes of the coli-like microbes :—

100 per cent. gave acid and gas in one or other of the lactose-peptone cultures.

100 per cent. produced greenish fluorescence in the neutral-red broth cultures.

Division V.

Appendix D.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings

100 per cent. produced acid and clot in one or other of the litmus milk cultures.

100 per cent. produced indol in one or other of the broth cultures.

It follows therefore that 100 *per cent. of the oysters contained coli-like microbes, indistinguishable, on the basis of the tests employed, from the typical B. coli of human intestinal origin.*

Crouch Oysters.

EXPERIMENT VII. (Crouch Oysters.)

On November 19th 1903, ten oysters obtained from the River Crouch were dealt with in the manner described in the first experiment of this series, the dilution method there set forth in detail being employed.

Primary cultures were in each instance made in sterile bile salt broth, and from each of the ten oysters (100 per cent.) one or more coli-like microbes were isolated by the gelatine plate method.

These microbes exhibited in pure culture the following characters :—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures.	Lactose peptone cultures.	* Neutral red broth cultures.	Broth cultures.	Litmus milk cultures.
A	1 c.c.	Gas N.L.§	Acid and gas	Positive.	No indol.	Acid, no clot.
	0·1 c.c.	Gas N.L.	No acid, no gas.	Positive.	No indol.	Acid, no clot
B	1 c.c.	Gas N.L.	Acid and gas.	Positive.	No indol.	Slight acid, no clot.
C	1 c.c.	Gas N.L.	Acid, no gas.	Negative.	No indol.	? Acid, no clot.
D	1 c.c.	Gas N.L.	Acid, no gas.	Negative.	No indol.	? Acid, no clot.
E	1 c.c.	Gas N.L.	Acid, no gas.	Negative.	No indol.	? Acid, no clot.
F	1 c.c.	Gas N.L.	No acid, no gas.	Negative.	No indol.	? Acid, no clot.
	0·1 c.c.		No coli-like microbes could be found.			
G	1 c.c.	Gas N.L.	Acid and gas.	Positive.	No indol.	Acid, slight clot.
	0·1 c.c.	Gas N.L.	No acid, no gas.	Positive.	No indol.	Acid, no clot.
H	1 c.c.	Gas N.L.	Acid and gas.	½ positive.	No indol.	Bleached, no clot.
I	1 c.c.	Gas N.L.	Acid, no gas.	Negative.	No indol.	Acid, no clot.
J	1 c.c.	Gas N.L.	Acid and gas.	½ positive.	No indol.	Acid, no clot.

§ N.L. indicates no liquefaction of gelatine within one month.

* "Positive" indicates the production of greenish-yellow fluorescence in this medium. "Negative" indicates that this change did not occur.

It will be noted from the foregoing table that five of the oysters (50 per cent.) each produced a microbe which formed when in pure culture acid and gas in the *lactose peptone medium.*; that not one of the microbes isolated formed *indol* in *broth cultures*; that only one (10 per cent.) of the oysters produced a microbe which *clotted milk*, and that in this instance this character was possessed in modified degree only by the microbe in question.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

Five microbes derived from three of the oysters (30°/₀—oysters A, B, G) produced a characteristic change in *neutral-red broth*. Two oysters (H and J) yielded each respectively a microbe which did not produce an entirely characteristic appearance in this medium (20°/₀). The microbes isolated from the remaining oysters (50°/₀) produced no definite change in the medium in question.

The net result was that, although all the ten oysters (100°/₀) contained coli-like microbes, the particular microbes chosen for subculture eventually proved in all cases atypical to a greater or less extent. Anticipating that this result was largely one of chance or degree (*i.e.*, amount of material used for cultural purposes), further experiments were instituted.

EXPERIMENT VIII. (Crouch Oysters).

On December 2nd 1903 ten oysters obtained from the River Crouch were dealt with in the manner described in the first experiment of this series with regard to the manner of preparing and opening the oysters and cutting up in their shells the bodies of the oysters. A sterile pipette was used in each instance to transfer as many c.c. as were obtainable of the liquid thus liberated to a tube containing sterile bile salt broth. The object of this modification was to discover whether or not the atypical characters of the coli-like microbes isolated in the previous experiment were to be attributed to accident or to the trifling amount of material subcultured or to both these factors combined. From each of the ten oysters (100°/₀) a non-liquefying coli-like microbe was isolated in pure culture by the gelatine plate method. The coli-like microbes thus obtained reacted as follows to certain tests :—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" Cultures.	Lactose peptone cultures.	*Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	4 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
B	3 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
C	4 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
D	4 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
E	4 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
F	5 c.c.	Gas	Acid and gas	Positive	No indol	Acid, no clot
G	4 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
H	3 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
I	4 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot
J	4 c.c.	Gas	Acid and gas	Positive	Indol	Acid and clot

* "Positive" indicates the production of greenish-yellow fluorescence in neutral-red broth. "Negative" indicates that this change did not occur.

The above table shows that no less than nine of the oysters (90 per cent.) yielded microbes, which in pure culture were, with regard to the tests employed, indistinguishable from the typical B. coli of the human intestine.

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Bacteriological Examination of individual oysters obtained from the Helford, Whitstable West Mersea, Crouch, Roach and yfleet layings.

The particular microbe which departed from this classic type, failed to form indol in broth and to clot milk, although in the latter medium it caused acidity to develop.

Experiment IX. (Crouch Oysters).

On December 5th 1903, ten oysters obtained from the River Crouch were opened with the usual precautions, after preparatory washing of their shells in the manner described elsewhere. Each oyster was cut once through with sterile scissors. Each oyster thus divided into two portions was transferred together with its liquor to a tube containing 50 c.c. of sterile bile salt broth.

The non-liquefying coli-like microbes, isolated from each of the oysters (100°/₀) by the gelatine plate method, respectively exhibited in pure culture the following characters :—

Oyster.	Gelatine "shake" cultures.	Lactose peptone cultures.	* Neutral-red broth cultures	Broth cultures.	Litmus milk cultures.
A	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
B	Gas.	Acid and gas.	Negative.	Indol (feeble).	Acid, no clot.
C	Gas.	Acid and gas.	?Positive.	Indol.	Acid and clot.
D	Gas.	Acid and gas.	Negative.	No indol.	Acid, no clot.
E	Gas.	Acid and gas.	Positive.	Indol.	Acid, slight clot.
F	Gas.	Acid, no gas.	Positive.	No indol.	Acid, no clot.
G	Gas.	Acid and gas.	Positive.	No indol.	Acid, no clot.
H	Gas.	Acid, very slight gas.	Positive.	No indol.	Acid, no clot.
I	Gas.	Acid, no gas.	Positive.	No indol.	Acid, no clot.
J	Gas.	Acid and gas.	Positive.	Indol.	Acid, slight clot.

* "Positive" indicates the production of greenish-yellow fluorescence in neutral-red broth. "Negative" indicates that this change did not occur.

The microbes derived from the four oysters A, C, E, J, (40 per cent.) bore a strong resemblance, when submitted to the tests detailed, to typical B. coli. The microbe derived from oyster A was with respect to these tests indistinguishable from typical B. coli. The microbe derived from oyster C did not develop in neutral-red broth entirely characteristic greenish-yellow fluorescence, but with regard to the other tests could not be distinguished from typical B. coli; the microbes derived from oysters E and J did not produce well marked clotting in milk cultures, but were, with respect to the other tests, indistinguishable from typical B. coli.

All the ten coli-like microbes isolated produced acid in the *lactose peptone medium,* eight microbes (80 per cent.) producing gas as well.

Seven of the microbes (70 per cent.) produced marked greenish-yellow fluorescence in *neutral-red broth,* in one microbe (10 per cent.) this reaction was not altogether typical, and two microbes (20 per cent.) failed to react to this test.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

Five microbes (50 per cent.) produced *indol in broth cultures.*

All the ten microbes produced *acidity in litmus milk,* while four (40 per cent.) *clotted the milk* in addition to producing acidity.

It will be noted that the percentage of typical B. coli isolated was lower in experiment IX. than was the case in experiment VIII. The truth seems to be that in testing oysters there would, as regards the B. coli test, appear to be an optimum quantity. If too little or too much of the material is used for cultural purposes atypical coli-like microbes are apt occasionally to be isolated.§

Roach Oysters.

EXPERIMENT X. (Roach Oysters).

On November 19th 1903, ten oysters obtained from the River Roach were dealt with in the quantitative and qualitative manner described in the first experiment of this series, the dilution method there set forth in detail being employed.

Primary cultures were in each instance made in sterile bile salt broth, and from nine out of the ten oysters one or more *non-liquefying* coli-like microbes were isolated by the gelatine plate method. These microbes exhibited in pure culture the following characters :—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures.	Lactose Peptone cultures.	* Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	1 c.c.	Gas.	Acid and gas.	Positive.	No indol.	Acid, no clot.
	0·1 c.c.	Gas.	Acid (?) gas.	Negative.	No indol.	Acid, no clot.
B	1 c.c.	Gas.	Acid and gas.	Positive.	No indol.	Acid, no clot.
C	1 c-c.	Gas.	Acid and gas.	(?) Positive.	No indol.	Acid and clot.
D	1 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
	0·1 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid, slight clot.
E	1 c.c.	Gas.	No acid, no gas.	Negative.	No indol.	Acid, no clot.
F	1 c.c.	Gas.	Acid and gas.	½ positive.	No indol.	Acid, slight clot.
	0·1 c.c.	Gas.	No acid, no gas.	½ positive.	No indol.	Acid, no clot.
G	1 c.c.	No coli-like microbes could be found.				
H	1 c.c.	Gas.	Acid, very slight gas	½ positive.	No indol.	Acid, no clot.
	0·1 c.c.	Gas.	Acid and gas.	Positive.	No indol.	Acid, no clot.
I	1 c.c.	Gas.	Acid and gas.	Positive.	No indol.	Acid, no clot.
	0·1 c.c.	Gas.	Acid and gas.	Positive.	No indol.	Acid, no clot.
J	1 c.c.	Gas.	Acid, slight gas.	Positive.	No indol.	Acid, no clot.
	0·1 c.c.	Gas.	Acid, no gas.	Negative.	No indol.	Acid, no clot.

* "Positive" indicates the production of greenish-yellow fluorescence in neutral-red broth. "Negative" indicates that this change did not occur.

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§ In the first case the reason is obvious, in the latter case the explanation is more difficult but probably depends on the fact that other bacteria multiply in the primary medium to such an extent as to swamp the typical B. coli.

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Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

It will seen from the foregoing table, that one of the oysters (10 per cent.) yielded microbes which were not distinguishable by the tests employed from the typical B. coli of the human intestine.

Eight (80 per cent.) of the oysters yielded microbes which in pure culture produced acid and gas in the *lactose peptone medium*; and the same proportion of the oysters yielded microbes which formed no indol in broth cultures. All the microbes isolated produced acidity in *litmus milk*, though but four microbes derived from three oysters (30 per cent.) also shewed tendency to clot milk.

Eight microbes derived from six oysters (60 per cent.) produced definite greenish-yellow fluorescence in *neutral-red broth*, four microbes derived from three oysters produced a questionably positive result in this medium, while three microbes failed altogether to approach the formation of the characteristic colour change.

The results of the following experiment are consistent with the atypical behaviour of so many of the coli-like microbes isolated from the Roach oysters having been due to employment of an insufficient amount of the oyster material for cultural purposes.

EXPERIMENT XI. (Roach Oysters).

On December 2nd 1903, ten oysters obtained from the River Roach were dealt with in the manner described in the first experiment of this series, with regard to the manner of preparing and opening the oysters, and cutting up in their shells the bodies of the oysters. A sterile pipette was use in each instance to transfer as many c.c. as were obtainable of the liquid thus liberated to a tube containing sterile bile salt broth. From each of the ten oysters (100 per cent.) there was isolated by the gelatine plate method a non-liquefying coli-like microbe which, in pure culture, exhibited the following characters:—

Oyster.	Amount of liquid in c.c.	Gelatine "shake" cultures.	Lactose peptone cultures.	*Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	4 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot
B	3 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
C	5 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
D	4 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
E	4 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
F	4 c.c.	Gas.	And and gas.	Positive.	Indol.	Acid and clot.
G	6 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
H	4 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid, slight clot.
I	9 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
J	6 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.

* "Positive" indicates the production of greenish-yellow fluorescence in neutral-red broth "Negative" indicates that this change did not occur.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

It is interesting to note that 100 per cent. of the oysters of experiment yielded microbes which, in pure culture, were indistinguishable, when submitted to the tests detailed, from the typical B. coli of the human intestine. It should, however, be remarked that the microbe derived from oyster H did not clot milk in so marked a manner as did the microbes derived from the other oysters.

With this single exception all the oysters (practically 100 per cent.) yielded microbes which, when submitted to the tests detailed were indistinguishable from the typical B. coli of the human intestine.

EXPERIMENT XII. (Roach Oysters).

On December 5th 1903, ten oysters obtained from the River Roach were opened with the usual precautions after preparatory washing of their shells in the manner described elsewhere. Each oyster was cut once through with sterile scissors. Each oyster thus divided into two portions was transferred, together with its liquor, to a tube containing 50 c.c. of sterile bile salt broth.

The non-liquefying coli-like microbes, isolated from the bile salt broth cultures of each of the oysters by the gelatine plate method, exhibited in pure culture the following characters:—

Oyster.	Gelatine "shake" cultures.	Lactose peptone cultures.	* Neutral-red broth cultures.	Broth cultures.	Litmus milk cultures.
A	Gas	Acid, no gas	Positive	No indol	Acid, no clot
B	Gas	Acid, slight gas	Positive	Indol (feeble)	Acid and clot
C	Gas	Acid, no gas	Positive	No indol	Acid, no clot
D	Gas	Acid and gas	Positive	No indol	Acid, no clot
E	Gas	No acid, no gas	Positive	No indol	Acid, no clot
F	Gas	Acid, no gas	Positive	No indol	Acid, no clot
G	Gas	Acid and gas	Positive	Indol	Acid and clot
H	Gas	Acid and gas	Positive	No indol	Acid, no clot
I	Gas	No acid, no gas	(?) Positive	No indol	Acid, no clot
J	Gas	Acid, no gas	Positive	No indol	Acid, no clot

* "Positive" indicates the production of greenish-yellow fluorescence in neutral-red broth. "Negative" indicates that this change did not occur.

One (oyster G) of the oysters (10 per cent,) yielded a microbe which presented in pure culture characters, with respect to the tests detailed, that were identical with those displayed by the typical B. coli of the human intestine. The microbe derived from oyster B approached closely to this classic type, but compared with the microbe from oyster G the indol produced in broth culture by the microbe derived from oyster B was feeble, and gas production in the lactose peptone medium was not copious.

Eight of the microbes produced acid in the *lactose peptone* medium, while four (40 per cent.) produced gas also. Two microbes (20 per cent.) failed altogether to respond to this test.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

Nine of the microbes (90 per cent.) produced a pronounced greenish-yellow fluorescence in *neutral-red broth*. One microbe (10 per cent.) possessed this character only in a minor degree.

The two microbes which bore marked resemblance to typical B. coli (20 per cent.) formed *indol in broth cultures*. Eight (80 per cent.) of the microbes did not exhibit this character.

Twenty per cent. of the microbes clotted and 80 per cent. failed to *clot milk*, although all the 10 microbes produced *acidity in milk*.

The cause of the atypical characters exhibited by the coli-like microbes isolated in this experiment as compared with the preceding experiment is, perhaps, partly due to an unsuccessful speculative choice of colonies for subculture, and partly to the circumstance that it is apparently possible to add too much as well as too little oyster liquid to the primary cultures, when the object is the isolation of typical B. coli from the secondary cultures. In some cases, in which too much of the material is added to the medium, atypical coli-like microbes appear to multiply more rapidly in the primary cultures than the typical B. coli, and these atypical microbes are apt to predominate in the secondary cultures.

Pyfleet Oysters.

EXPERIMENT XIII. (Pyfleet Oysters).

On December 3rd 1903, ten Pyfleet oysters (collected December 2nd) were dealt with in the quantitative and qualitative manner described in the first experiment of this series, the dilution method there set forth in detail being employed (*see* Experiment I., page 258).

Further, the macerated body of each oyster with its residual liquor (after the 2 c.c. necessary respectively for inoculating a sterile bile salt broth tube, and for making the dilutions in sterile distilled water had been abstracted) was added to a tube containing 50 c.c. of sterile bile salt broth. Coli-like microbes were isolated by the gelatine plate method from (*a*) the liquor, and (*b*) the body and liquid of each oyster. None of these microbes liquefied gelatine.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

These microbes exhibited in pure culture the following characters :—

Oyster.	Amount used for cultural purposes.	Gelatine "shake" cultures.	Lactose peptone cultures.	*Neutral red broth cultures.	Broth cultures.	Litmus milk cultures.
A	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	0·1 c.c. of liquid	Gas	Acid, no gas	Positive	No indol	Acid, no clot
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
B	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
C	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	0·1 c.c. of liquid	No coli-like microbes could be found.				
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
D	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
E	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	0·1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
F	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	0·1 c.c. of liquid	No coli-like microbes could be found.				
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
G	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
H	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
I	1 c.c. of liquid	Gas	Acid, slight gas	Negative	No indol	Acid, no clot
	0·1 c.c. of liquid	Gas	Acid, slight gas	Negative	No indol	Acid, no clot
	Body and liquid (— 2 c.c.)	Gas	Acid and gas	Positive	Indol	Acid and clot
J	1 c.c. of liquid	Gas	Acid and gas	Positive	Indol	Acid and clot
	0·1 c.c. of liquid	No coli-like microbes could be found.				
	Body and liquid (— 2 c.c.)	Gas	Acid, no gas	Positive	Indol	Acid, no clot

* "Positive" indicates the production of a greenish-yellow fluorescence in neutral red broth. "Negative" indicates that this change did not occur.

It will be seen on studying this table, that from each of the ten oysters (100 per cent.) one or more microbes were isolated which, in their behaviour to the tests detailed, could not be distinguished from the typical B. coli of the human intestine.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

Three of the oysters (30 per cent.) were found to contain coli-like microbes in 0·1 c.c. of their liquid. In the case of oyster E, the microbe isolated from 0·1 c.c. of oyster liquid differed in no respect, when submitted to the tests detailed, from the typical B. coli.

All of the ten oysters (100 per cent.) contained coli-like microbes in 1 c.c. of their liquid, and it is noteworthy that 90 per cent. of these microbes isolated from 1 c.c. of oyster liquid were indistinguishable, with regard to the tests detailed, from the typical B. coli of the human intestine.

The oyster body and the residual liquid (after abstraction of the 2 c.c.) contained in each of the ten experiments coli-like microbes. Of the microbes isolated, 90 per cent. were indistinguishable from the typical B. coli of the human intestine.

It is noteworthy that in no instance did any of the ten oysters fail to contain at least one microbe indistinguishable from typical B. coli; 10 per cent. of the oysters containing a number corresponding to at least 10 per c.c.; 90 per cent. at least 1 per c.c.; and 10 per cent. at least 1 per oyster.

Summary and Conclusions.

In summary of the foregoing the following points should be noted:—

The Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet oyster layings have all been approved on topographical grounds, either because sewage pollution is practically absent or because, owing to the set of the tides, effect of dilution, and other factors, the sewage is conjectured to reach the layings in none but negligible amount; or perhaps for the reason that the sewage would have to travel so far, or take so long a time to reach the layings, as to bring the conditions under the designation "*remote* sewage pollution." These layings are indeed considered to be, from the topographical point of view, among the purest (some of them perhaps *the purest*) layings around the *English Coast.*

To suggest therefore that the oysters from these layings are impure, in the sense that they are a source of danger to health, would be a grave step to take. It would be equivalent to implying that secure conditions of oyster culture in England are practically unattainable.

In discussing the facts observed in view of the considerations involved, I am accepting here, as indeed throughout this report, the judgment of the topographist as if it were final. At the same time, this need not always necessarily imply my complete personal agreement. Meanwhile I, as a bacteriologist, offer no opinion as to the possibility or otherwise of oysters from these layings giving rise to epidemic disease.

Quantitative Results.

As regards the bacteriological facts, it will be convenient to consider, in the first place, the results of the *quantitative* examinations for coli-like microbes of each oyster out of a batch of ten oysters derived from each of the foregoing layings.

For this purpose, reference should be made to Experiments I., II., IV., VII., X., and XIII.

Estimated number of Coli-like Microbes per c.c. of Oyster Liquid (mixed Liquid and Juices of Oyster).

Oyster	1	2	3	4	5	6	7	8	9	10
Helford - - -	100	100	100	100	100	100	100	10	10	10
Whitstable - -	10	10	10	10	10	1	1	1	1	1
West Mersea - -	10	10	10	10	1	1	1	1	1	None
Crouch - - -	10	10	1	1	1	1	1	1	1	1
Roach - - -	10	10	10	10	10	10	1	1	1	None
Pyfleet - -	10	10	10	1	1	1	1	1	1	1

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

It is important to note that it is not suggested that these figures should be accepted as indicating the respective merits of the different oysters.

The point of interest is that as regards 60 oysters (10 from each of six separate layings) the number of coli-like microbes present corresponded :—

In 7 oysters (11·6 %) to one hundred
,, 23 ,, (38·3 %) ,, ten
,, 28 ,, (46·6 %) ,, one
,, 2 ,, (3·2 %) ,, not any
} coli-like microbes per c.c. of oyster liquid (mixed liquor and juices of oyster).

Of course, many of these coli-like microbes were not identical in behaviour with typical B. coli, but the question of biological attributes will next receive attention. The chief point emphasized at this stage is the fact that practically all the oysters derived from certain of the *reputedly* purest layings in England could be regarded as containing from 1 to 100 coli-like microbes per c.c. of oyster liquid (mixed liquor and body juices).

Qualitative Results.

As regards a list of the biological characters of the B. coli contents of individual oysters, much depends on the amount of material used for cultural purposes, and also on the "chances" involved in the speculative choice of colonies for subculture. This being understood, it is justifiable in relation to my thesis, to select the particular batch of ten oysters from each of the six layings which, when submitted to examination, yielded the most typical B. coli.*

As the constant repetition of the results of sub-cultural tests is apt to grow wearisome, the word "flaginac" will be used in the following sense :—

fl	ag	in	ac
Indicates greenish-yellow fluorescence in neutral-red broth cultures.	Indicates acid and gas in lactose-peptone cultures	Indicates indol formation in broth culture.	Indicates acidity and clotting of litmus milk cultures.

The word "flaginac," thus indicates that a microbe was indistinguishable, as regards the tests employed, from the typical B. coli of the human intestine. Whenever letters are placed in brackets, this indicates an incomplete reaction. The absence of a character is expressed by the omission of the letters chosen to indicate that attribute.

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* It must be understood definitely, that I have *not*, as regards any of the layings, selected oysters from *separate* batches, so as to make up a total of ten oysters, but have chosen the particular batch of ten oysters out of a series of batches of ten oysters yielding the most typical B. coli.

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Appendix D.

Bacteriological Examination of individual oysters obtained from the Helford, Whitstable, West Mersea, Crouch, Roach and Pyfleet layings.

Biological Attributes of the most typical Coli-like Microbes derived from each of 60 Oysters independently of their relative Abundance.

Oysters	1	2	3	4	5	6	7	8	9	10
Helford - Experiment I.	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac
Whitstable Experiment III.	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flag (ac)	Agac
W. Mersea Experiment VI.	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac
Crouch - Experiment VIII.	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flag
Roach - - Experiment XI.	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flagin(ac)
Pyfleet - Experiment XIII.	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac	Flaginac

It thus appears as regards 60 oysters (10 from each of six separate layings), all of which contained coli-like microbes, that the biological attributes of the microbes in question may be expressed as follows :—

56 oysters contained "flaginac" microbes
1 oyster ,, flagin(ac) ,,
1 oyster ,, flag(ac) ,,
1 oyster ,, agac ,,
1 oyster ,, flag ,,

That is, 93 per cent. of the oysters contained microbes indistinguishable as regards the tests employed, from the typical B. coli of the human intestine.

The inference is that practically all the best known English oysters are liable to contain, given a batch of ten oysters, coli-like microbes in each of the ten oysters (100 per cent.), and that in many cases these coli-like microbes may be indistinguishable, as regards the tests employed, from the typical B. coli of the human intestine.

The matter may be regarded as one of *proportion*; and, in the circumstances, until the "permissible degree of biological impurity" can be defined no English oysters should be condemned on bacteriological grounds alone, unless, indeed, the results indicate bacteriologically such *gross* pollution as to afford no possible room for doubt of their objectionable quality. This does not mean that the quantitative and qualitative bacterioscopic examination of oysters is unimportant. The contrary is my own view, but until knowledge is more complete, it would, I consider, be unjustifiable to damage an important industry by relying *exclusively* on the bacteriological facts, the *precise* interpretation to be placed on these facts remaining a matter for speculation.

Meanwhile demonstration of the *mere presence* of B. coli, as the result of qualitative bacteriological analysis, even in 90 per cent. of a batch of oysters from any layings around the English coast would seem, in face of the above results, insufficient to condemn such layings.

APPENDIX E.

Division V., App. E.

Effect, from the Bacteriological point of view, of exposing the bodies of Oysters (freed from their shells) to various germicidal solutions.

Experiments designed to ascertain whether immersion for a considerable time of the bodies of oysters (freed from their shells) in strong germicidal solutions is to be relied on to destroy B. coli (or coli-like microbes); whether, that is, these microbes are or are not contained within the alimentary tract of the oyster.

EXPERIMENT 1.

August 29*th* 1903.

The oysters* experimented upon were four in number, and were gathered, at high tide, in the Penryn River, at 9.0 a.m. on August 28th. The oysters were cleaned and opened in the manner described elsewhere. They were then detached from the shell with a sterile knife. Two oysters (*a* and *b*) were soaked, without further treatment, in 5 per cent. carbolic acid solution for one hour, while the remaining two oysters (*c* and *d*) were similarly treated after the mantle lobes and gills had been cut off. Each oyster was washed in sterile water, then cut up with sterile scissors, and added to a flask containing 20 c.c. taurocholate-peptone-glucose medium.

The result of incubation at 37° C. showed that in no case was acid or gas produced in the medium. This negative result does not necessarily, however, prove the absence of coli-like microbes from the alimentary canal of the oyster; for it is possible that either the antiseptic may have penetrated there or that enough disinfectant may, despite the washing, have adhered to the outside of the oyster to inhibit growth of coli-like microbes, if present. Indeed, subsequent experiments showed that either the one or the other explanation is in all probability correct.

EXPERIMENT 2.

August 28*th* 1903.

Oysters† (three in number) from Penryn River, gathered on August 27th at low tide, were used for this experiment. These oysters were treated as in the previous experiment (oysters *a* and *b*), and were soaked for one hour in a 5 per cent. solution of carbolic acid. After being washed with sterile water, and cut up with sterile scissors, each oyster was added to a separate flask containing sterile taurocholate-glucose-peptone medium.

On incubation, growth ensued in each of the three flasks, and from each by the gelatine plate method a coli-like microbe (I., II., III.) was isolated in pure culture. Coli-like microbes I., II., and III. exhibited the following cultural characters:—

——	Coli-like Microbe. I.	Coli-like Microbe. II.	Coli-like Microbe. III.
Gelatine "shake" cultures	Gas.	Gas.	Gas.
Lactose peptone ,, ...	Acid and gas.	Acid and gas.	Acid and gas.
Neutral-red broth ,, ...	Greenish-yellow fluorescence.	Greenish-yellow fluorescence (½ positive result)	Greenish-yellow fluorescence.
Broth ,, ...	Indol.	Indol	Indol.
Litmus milk ,, ...	Acid and clot.	Acid and clot.	Acid and clot.
	No liquefaction of gelatine (one month).		

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* The oysters used in this experiment were from the same batch as those employed in the routine experiment No. 6 (*see* report on Helford and Penryn oysters, Division IV).

† The oysters used belonged to the same series as those of Experiment No. 6 of the routine analysis (*see* report on the Helford and Penryn oysters, Division IV).

Effect, from the Bacteriological point of view, of exposing the bodies of Oysters (freed from their **shells**) to various germicidal solutions.

It will be seen that coli-like microbes I. and III. differed in none of the cultural tests to which they were submitted from typical B. coli. Coli-like microbe II. also approximated very closely to typical B. coli.

It is apparent from this experiment that immersion of an oyster for one hour in 5 per cent. carbolic acid solution was insufficient to inhibit the growth or impair the vitality of coli-like microbes present within the body of the oyster itself.

EXPERIMENT 3.

September 8th 1903.

The oysters* employed in this experiment were gathered in the Helford River at low tide on September 7th. After having been cleaned, opened, and carefully detached from the shell, with the usual precautions, they were allowed to remain for 1½ hours in a 5 per cent. solution of carbolic acid, and were afterwards washed with sterile water. Each oyster was then cut up with sterile scissors and transferred to a flask containing 50 c.c. of sterile taurocholate-peptone-glucose medium.

Two oysters were examined in this manner, a positive result being obtained in one case and a negative result in the other.

From the culture in which growth occurred, a gelatine plate was made from which a microbe was isolated, yielding in pure culture the following characters :—

Gelatine "shake" culture - - - -	Gas.
Lactose peptone ,, - - - -	Acid and gas.
Neutral-red broth ,, - - - -	Greenish-yellow fluorescence.
Broth culture ,, - - - -	No indol.
Litmus milk ,, - - - -	Acid and clot.

No liquefaction of gelatine had occurred after lapse of one month.

It will be seen that this coli-like microbe, except in its failure to form indol, was indistinguishable, when submitted to the above cultural tests, from typical B. coli.

The foregoing experiments serve to show that, although in the case of the four Penryn oysters of the first experiment no coli-like microbes could be isolated from the bodies of the oysters after one hour's immersion in 5 per cent. carbolic acid solution, immersion for the same period of time in carbolic acid of the same strength did not suffice to kill coli-like microbes in any one of three other Penryn oysters thus treated. Indeed, systematic testing revealed that two out of the three microbes thus isolated differed not at all from typical B. coli in the subcultural reactions to which they were submitted, while the third differed in this sense to a very slight extent from typical B. coli. Further, in the case of the Helford oysters, 1½ hours immersion in 5 per cent. carbolic acid solution did not, in one out of two instances, suffice to kill coli-like microbes present within the body of the oyster. It is noteworthy that the strain of coli-like microbes isolated in this later case closely resembled typical B. coli in the several cultural tests carried out.

EXPERIMENT 4.

August 27th 1903.

An oyster†, gathered on August 26th, from the Penryn River at low tide, was used for this experiment. The oyster was cleaned, and opened with the usual precautions, then detached with a sterile knife from its shell, and transferred to soak in a 5 per cent. copper sulphate solution for ½ hour; after this the oyster was washed in sterile water, and finally it was cut up and transferred to a flask containing 100 c.c. of sterile taurocholate-glucose-peptone medium.

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* The oysters employed belonged to the same series as those of the routine examination No. 17 (Division IV.).

† The oyster used for this experiment corresponded to those used in Experiment 6 of the routine examination (*See* report on the Helford and Penryn oysters, Division IV.).

Division V., App. E.

Effect, from the Bacteriological point of view, of exposing the bodies of Oysters (freed from their shells) to various germicidal solutions.

A gelatine plate was prepared from the flask in which acid and gas developed, and a microbe thus isolated in pure culture was submitted to detailed subcultural tests.

Characters of microbe isolated from a Penryn oyster which had been soaked in 5 per cent. copper sulphate solution for half hour :—

Gelatine "shake" culture - - -	Gas.
Lactose peptone „ - - - -	Acid and gas
Neutral-red broth „ - - - -	Greenish-yellow fluorescence (½ positive result).
Broth „ - -	No indol.
Litmus milk „ - - -	Acid and clot.

This microbe was, subsequently found slowly to liquefy gelatine ; in other respects, however, it bore a near resemblance to some strains of B. coli.

This experiment serves to show that half an hour's immersion in a 5 per cent. solution of copper sulphate was insufficient entirely to destroy all microbes which might possibly be considered akin to B. coli.

EXPERIMENT 5.

September 8th 1903.

The oysters* employed in this experiment were gathered in the Helford River at high tide on September 7th. They were cleaned and opened in the manner described elsewhere, then allowed to remain, after having been carefully detached from the shell with a sterile knife, in 1 in 500 corrosive sublimate solution for 1½ hours. The oysters were then washed with sterile water, cut up, and each macerated oyster was transferred to a separate flask containing 50 c.c. of sterile taurocholate-peptone-glucose medium. Four oysters were thus examined, and in one case a positive result was obtained, a coli-like microbe being isolated from a gelatine plate made from the original culture ; the three other cultures gave negative results.

The coli-like microbe exhibited in pure culture the following characters :—

Gelatine "shake" culture - - - -	Gas.
Lactose peptone „ - - -	Acid and gas.
Neutral-red broth „ - - - -	Greenish-yellow fluorescence.
Broth „ - - - -	No indol.
Litmus milk „ - - - -	Acid and clot.

No liquefaction of gelatine had occurred after lapse of one month.

This experiment shows that exposure to corrosive sublimate 1 in 500 for 1½ hours, was in one out of four instances insufficient to inhibit the growth of coli-like microbes present within the body of the oyster immersed in the "germicide." It is noteworthy, that the microbe isolated in pure culture from the macerated oyster body differed only to a slight extent in the subcultural reactions detailed above from typical B. coli.

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* The oysters employed belonged to the same series as those of the routine examination, No. 16. (*See* report on the Helford and Penryn oysters, Division IV.)

Experiment 6.

September 16th 1903.

Division V., App. E.

Effect, from the Bacteriological point of view, of exposing the bodies of Oysters (freed from their shells) to various germicidal solutions.

Four Penryn oysters collected at high tide on September 15th, were cleaned in the manner described elsewhere, and opened severally with a sterile knife; and on removal in this manner from their shells, the oysters were immersed for a quarter of an hour respectively in the following solutions:—the first oyster (*a*) in absolute alcohol, the second oyster (*b*) in 2°/$_0$ carbolic acid solution, the third (*c*) in 1 in 1,000 mercuric chloride solution, and the fourth (*d*) in 5°/$_0$ copper sulphate solution. When the quarter of an hour had expired, each oyster was separately removed from the solution by means of sterile forceps, and sterile water poured over it. It was next transferred without cutting it up to a separate tube containing 50 c.c. of sterile bile salt broth (cultures (*a*), (*b*), (*c*), (*d*)). Cultures (*a*), (*b*), (*c*), yielded coli-like microbes which, in pure culture, exhibited the following characters:—

——	(*a*) Absolute Alcohol.	(*b*) 2°/$_0$ Carbolic Acid.	(*c*) Mercuric Chloride 1 in 1,000.
Gelatine "shake" cultures*	Gas.	Gas.	Gas.
Lactose peptone ,, ...	Negative.	Acid and gas.	Acid and gas.
Neutral-red broth ,, ...	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, ...	No indol.	Indol.	No indol.
Litmus milk ,, ...	Acid and clot.	Acid, no clot.	Acid and clot.

This experiment shows that, although in this instance immersion for ¼ hour in 5°/$_0$ solution of copper sulphate† sufficed to kill all coli-like microbes, immersion for the same period failed to effect this when absolute alcohol, 2°/$_0$ carbolic acid solution, and ·1°/$_0$ solution of mercuric chloride were used.

The experiments, as a whole, serve to show that germicidal solutions, in the strengths used and during the allotted time of exposure, may fail to destroy the vitality of B. coli or coli-like microbes, presumably because these bacteria are contained within the body of the oyster. It is well known that the microbes in question, if *per se* exposed to the action of germicidal solutions of the sort and in the strengths detailed, would not fail rapidly to succumb. The evidence therefore leads to the inevitable conclusion that the microbes must have been protected by the tissue of the oyster body from the germicidal action. The presence of the microbes in the alimentary tract, for instance, would be consistent with this view. It follows, therefore, that negative results obtained by the bacteriological examination of the liquor of the oyster irrespective of the interior juices of the oyster are not to be unreservedly accepted.

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* Microbe (*a*) slowly liquefied the gelatine. Microbes (*b*) and (*c*) did not liquefy gelatine (one month).

† It will be seen from a foregoing experiment that immersion in copper sulphate of the same strength for double the time was insufficient to inhibit the growth of coli-like microbes.

APPENDIX F

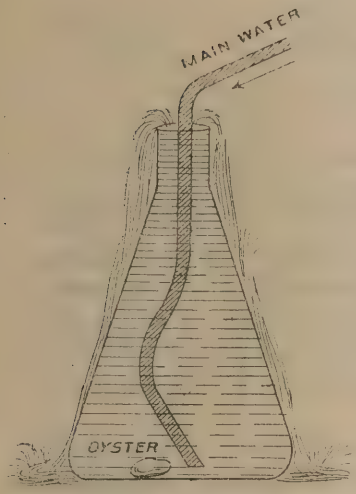
Division V.,
App. F.

Effect, from the Bacteriological point of view, of "washing" the bodies of Oysters (freed from their shells).

Experiments to ascertain whether or not washing the body of an oyster frees it from B. coli or coli-like microbes.

EXPERIMENT I.

August 26th 1903.



The following experiment was made in order to ascertain whether B. coli or coli-like microbes present in oysters are situated in the oyster itself (or so firmly attached to the oyster as to be incapable of being washed away), or in the oyster liquor. The oyster employed was gathered from the Helford River at high tide on August 25th.

This oyster was cleaned, and opened with the precautions detailed elsewhere; and of the liquor, 1 c.c. (culture A) and $\frac{1}{10}$ c.c. (culture B) respectively, were examined for B. coli.

The body of the oyster was then removed from the shell with as little injury as possible to its substance, and transferred to a sterile flask and washed (see figure), for $1\frac{1}{2}$ hours in fast running main water, then repeatedly with sterile water, and finally the body was cut up and added to 100 c.c. taurocholate-peptone-glucose medium in a flask.

As was anticipated, coli-like microbes were isolated not only from the cultures made from the liquor (in the A culture indistinguishable with regard to the tests employed from typical B. coli), but also from the culture containing the *washed body of the oyster*. The experiment seems to indicate that it is impossible to wash an oyster free from coli-like microbes.

The characters of the microbes isolated were as follows:—

——	Liquor of oyster 1 c c. (culture A).	Liquor of oyster $\frac{1}{10}$ c.c. (culture B).	Washed body of oyster.
Gelatine "shake" cultures - -	Gas.	Gas.	Gas.
Lactose peptone ,, - - -	Acid and gas.	Negative.	Acid and gas.
Neutral-red broth ,, - - -	Greenish-yellow fluorescence.	Negative.	Greenish-yellow fluorescence.
Litmus milk ,, - - -	Acid and clot.	Acid, no clot.	Acid and clot.
Broth ,, - -	Indol.	Indol.	Indol.
	No liquefaction of gelatine. (One month).	No liquefaction of gelatine (one month), but some yellowish colouration of medium.	No liquefaction of gelatine. (One month).

EXPERIMENT 2.

September 8th 1903.

The following experiment was also made to determine whether all the coli-like microbes found in the oyster were derived from the liquor in the shell, or whether they were present in the interior of the oyster itself, or were so firmly adherent to the oyster as to be incapable of being washed away.

Effect, from the Bacteriological point of view, of "washing" the bodies of Oysters (freed from their shells).

Oysters from the Penryn River, gathered on September 7th at low tide, were chosen for the experiment.* Three of these oysters were opened with the precautions described elsewhere, carefully detached from their shells and washed in fast running main water for 3½ hours (*see* figure). They were then washed repeatedly with sterile water, after which each oyster was cut up, and added to one of three flasks (A, B, C), containing each 50 c.c. taurocholate-peptone-glucose medium.

Typical B. coli, as regards the tests detailed, was obtained in all these cases. The biological characters were as follows :—

——	Flask A.	Flask B.	Flask C.
Gelatine "shake" cultures -	Gas.	Gas.	Gas.
Lactose peptone ,, - -	Acid and gas.	Acid and gas.	Acid and gas.
Neutral-red broth ,, - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Litmus milk , - -	Acid and clot.	Acid and clot.	Acid and clot.
Broth , - -	Indol.	Indol.	Indol.

These experiments seem clearly to indicate that no amount of washing can, within a reasonable space of time, free an oyster from coli-like microbes.

EXPERIMENT 3.

Five oysters obtained from the Helford River layings at high tide and five oysters obtained from Helford at low tide were washed in the manner described elsewhere, and in opening the usual precautions were carefully observed. Each oyster was opened with a sterile knife, carefully detached from the shell, and while the oyster was held in sterile forceps 45 c.c. of sterile water were poured over it. Then the whole oyster was dropped into 50 c.c. of sterile bile salt broth contained in a wide-mouthed glass tube.

In this manner cultures (*a*), (*b*), (*c*), (*d*), (*e*) were made from the oysters obtained at low tide, and cultures (*f*), (*g*), (*h*), (*i*), (*j*) from the oysters obtained at high tide. In every case on incubation growth, as testified by the development of acid and gas in the medium, ensued. Gelatine plate cultures were made in each instance, and the varieties of coli-like microbes isolated yielded in pure cultures the following characters :—

"Washed" Oysters from Helford River (low tide).

———	(a)	(b)	(c)	(d)	(e)
Gelatine "shake" cultures	Gas.	Gas.	Gas.	Gas.	Gas.
Lactose peptone ,,	Acid and gas.	Acid and gas.	Acid and gas.	Acid and gas.	Acid and gas.
Neutral-red broth ,,	Greenish-yellow fluorescence. ($\frac{3}{4}$ positive.)	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth - - ,,	Indol.	Indol.	Indol.	Indol.	No indol.
Litmus milk - ,,	Acid and clot.	Acid and clot.	Acid, slight clot.	Acid, slight clot.	Acid, no clot.

None of these microbes liquefied gelatine within one month.

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* The oysters used in this experiment belonged to the same series as those of the routine experiment 10, Division IV.

Effect, from the Bacteriological point of view, of "washing" the bodies of Oysters (freed from their shells).

' Washed" Oysters from Helford River (high tide).

———	f)	(g)	(h)	(i)	(j)
Gelatine 'shake" cultures	Gas.	Gas.	Gas.	Gas.	Gas.
Lactose peptone „	Acid and gas.	Acid and gas.	Acid and gas	Acid and gas.	Acid and gas.
Neutral-red broth ,	Negative.	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.	Greenish-yellow fluorescence,	Greenish-yellow fluorescence.
Broth - - „	No indol	Indol.	Indol.	Indol.	Indol.
Litmus milk - „	Acid, no clot.	Acid and clot.	Acid, slight clot.	Acid and clot.	Acid, slight clot.

None of these microbes liquefied gelatine within one month.

It is noteworthy that of the coli-like microbes isolated from these oysters, some varieties were, when tested in the manner detailed above, practically indistinguishable from typical B. coli. The majority of the remaining varieties approached closely to the type of the classical B. coli. An interesting point is that all the coli-like microbes (100 per cent.) isolated from these oysters produced acid and gas in lactose peptone medium, and this test is, in the opinion of some bacteriologists, of superlative diagnostic significance where B. coli is concerned.

This experiment shows that *each* of ten oysters separately washed and placed in separate tubes of culture medium was found to contain B. coli (or coli-like microbes) either in its interior or so firmly attached to it as to render removal by washing impossible.

Notwithstanding the fact that the Helford oysters come from a river which, on topographical grounds, would be judged to be of great purity, each of the ten oysters (100 per cent.) contained B. coli or coli-like microbes. It would therefore seem to be unjustifiable to condemn oysters owing to the *mere presence* certainly of coli-like microbes, probably even of completely typical B. coli in them.

It may indeed reasonably be doubted whether (excepting deep sea oysters), there can easily be found on any layings around our English shores a majority out of a batch of oysters which do not contain B. coli or coli-like microbes.

EXPERIMENT 4.

Ten oysters obtained at high tide from the Helford River were prepared in the manner described elsewhere, and then carefully detached with a sterile knife from their shells. They were then placed in a sterile beaker and washed for three and a half hours under a rapid stream of tap water coming direct from the main. The oysters were then separately extracted with sterile forceps, and, before being cut up with sterile scissors, each oyster was washed with 45 c.c. of sterile water. Each oyster was then held with sterile forceps over a sterile 1,000 c.c. cylinder, and cut up with sterile scissors, the pieces being allowed to drop into the cylinder.

The bulk of the oysters was found to be 100 c.c. Sterile water was then added in order to fill up to the 1,000 c.c. mark, and the mixture carefully stirred with a sterile glass rod. From this mixture of sterile water and macerated oyster bodies cultures were made in peptone-glucose-bile-salt medium. Coli-like microbes were isolated from cultures made from 100 c.c. (1 coli-like microbe per oyster) and 10 c.c. (10 coli-like microbes per oyster) respectively of the macerated oyster bodies and sterile water. The following

Division V., App. F.

Effect, from the bacteriological point of view, of "washing" the bodies of oysters (freed from their shells).

were the characters exhibited in pure culture by the microbes thus isolated :—

—	Microbe isolated from 100 c.c. (1 B. coli per oyster.)	Microbe isolated from 10 c.c. (10 B. coli per oyster.)
Gelatine "shake" cultures -	Gas.	Gas.
Lactose peptone ,, -	Acid and gas.	Acid and gas.
Neutral-red broth ,, -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, -	Indol.	Indol.
Litmus milk , -	Acid and clot.	Acid and clot.

No liquefaction of gelatine occurred after the lapse of one month.

It is noteworthy that, when submitted to the foregoing tests, neither of the microbes isolated could with respect to the tests employed, be distinguished from typical B. coli. It is interesting to observe that 3½ hours, washing of the oyster bodies was insufficient to deprive them of coli-like microbes, in that such microbes were found, as is obvious from the quantities used for culture, to number on an average at least 10 in every oyster.

Experiments of this sort show the necessity of examining bacteriologically the whole contents of the oyster shell.

APPENDIX G.

A Quantitative Series of Experiments to ascertain the relation between the biological composition of (1) the shell liquor and surface "washings" of the oyster, and (2) the "washed" body of the oyster.

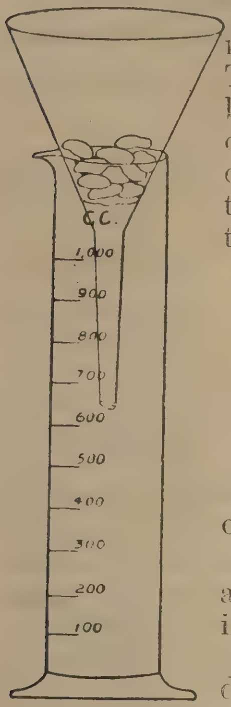
Division V., App. G.

Comparison, bacteriologically, between (a) the liquor and "washings" of oysters, and (b) the "washed" bodies of oysters.

EXPERIMENT A.

September 9th 1903.

The oysters utilised for this experiment were gathered in the Helford River, at low tide, on September 8th. They were cleaned in the manner described elsewhere, before being opened with a sterile knife. Each oyster was carefully detached from the two valves of its shell, with as little injury as possible, and washed in the manner about to be described.



A sterilised funnel was placed in a sterile 1,000 c.c. measuring cylinder as shown in the accompanying figure. The liquor in the oyster shell was poured into the cylinder before the oyster was completely detached, and then the oyster was removed from the shell with sterile forceps, held over the funnel, well washed with sterile water, and allowed to rest in the funnel. Ten oysters were treated severally in this manner, and then allowed to drain in the funnel.

I. Liquor.

The total amount of sterile water employed for washing purposes was ... ... 810 c.c.

The total volume of liquid (oyster liquor and "washings") in the measuring cylinder was 840 c.c.

Therefore the volume of oyster liquor for 10 oysters was ... ... 30 c.c.

or 3 c.c. liquor per oyster.

The funnel containing the oysters was then lifted into a second sterile cylinder, and sterile water was poured into the first cylinder up to the 1,000 c.c. mark.

The cultures were then carried out in the ordinary way described elsewhere.

Results of the Examination of the Liquor.

Coli-like microbes were isolated in pure culture from 1 c.c. and 0·1 c.c. of the litre of mixed oyster liquor and sterile water.

When sub-cultured these microbes were found to be possessed of the following characters :—

——	1 c.c.	0·1 c.c.
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid and gas.
Neutral-red broth ,, - - - -	Greenish-yellow fluorescence.	Negative.
Broth ,, - - - -	No indol.	No indol.
Litmus milk ,, - - - -	Acid and clot.	Acid and clot.
	No liquefaction after one month.	Slow liquefaction.

This result indicates that the litre consisting of oyster liquor + sterile water contained coli-like (apart from *slow* liquefaction of gelatine) microbes in amount corresponding to about 10 per c.c. The whole litre could thus be considered to contain about 10,000 coli-like microbes derived from 30 c.c. of oyster liquor.

Comparison, bacteriologically, between (a) the liquor and "washings" of oysters, and (b) the "washed" bodies of oysters.

Hence, if 10 oysters yield 30 c.c. of liquor containing 10,000 coli-like microbes, taking the average liquid contents of each oyster as 3 c.c., this works out at 1,000 coli-like microbes in the liquid contents of each oyster, or about 330 coli-like microbes per c.c. of oyster liquor.

II. *Oysters.*

The oysters were one by one removed from the funnel, cut up with sterile scissors, and placed in the second sterile cylinder. A known quantity of sterile water (100 c.c.) was then added, the total volume read off, and hence after deducting 100 c.c. the volume of the oysters was obtained. It was found to be 90 c.c. Sterile water was then added to the cylinder until the volume of the liquid was equal to 1,000 c.c.

The cultures were then carried out in the ordinary way described elsewhere.

Results of the Examination of the Oysters' Bodies.

Coli-like microbes were respectively isolated from 10 c.c. and 1 c.c. of the litre consisting of a mixture of washed oyster bodies and sterile water.

The cultural reactions of these microbes in pure culture were respectively as follows :—

——	10 c.c.	1 c.c.
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid and gas.
Neutral-red broth ,, - - - - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, - - - -	No indol.	No indol.
Litmus milk ,, - - - - - -	Acid, no clot.	Acid and clot.

No liquefaction of gelatine had occurred after the lapse of one month.

The litre consisting of sterile water + macerated oysters might be considered to contain about 1,000 coli-like microbes derived from the bodies of 10 oysters. Therefore, each oyster body (deprived as far as possible of its natural liquor) would contain coli-like microbes corresponding in number to about 100.

The total volume of oyster bodies being 90 c.c., the volume of each of the 10 oysters averaged 9 c.c. ; each 9 c.c. of oyster body could be considered to contain 100 coli-like microbes, or, roughly speaking, 11 coli-like microbes *per c.c. of body bulk.* The contrast is very striking when this number is compared with that of 330 coli-like microbes per c.c. of oyster liquor, *i.e., volume for volume* the oyster liquor contains about 30 times as many coli-like microbes as the oyster body.

But the liquid contents of the oyster's stomach are certainly much less than 1 c.c., probably about 0·1 c.c. It is probable that the coli-like microbes isolated from the macerated oyster bodies in the foregoing experiment were totally, or in great part, derived from the contents of the stomach and intestinal tract. In fact, it is conceivable that the 100 coli-like microbes, which each washed oyster was found to contain, were all, or to a great extent, derived from the stomach juice which, for comparative purposes, may be assumed to be about 0·1 c.c. But if the body volume of each oyster be taken as 9 c.c., the volume of the stomach contents on the above assumption is only about one-ninetieth of the total bulk.

This view alters considerably the complexion of affairs. For the ratio between the number, per unit of volume, of coli-like microbes present respectively, in the oyster liquor and stomach juice, would then be 33 : 100. In other words, acting on this assumption the coli-like microbes were three times more numerous per unit of volume in the stomach or intestinal juice than in the oyster liquor.

Experiment B. (*September* 30*th*, 1903).

Ten oysters obtained from layings in the Porthcuel River (*see* Division

Comparison, bacteriologically, between (a) the liquor and "washings" of oysters and (b) the "washed" bodies of oysters.

IV., Addendum C.) were used for this experiment. The procedure was the same as in Experiment A.

The volume of liquor obtained from the bodies of the 10 oysters was found to be 75 c.c. The amount of sterile water employed in washing the 10 oyster bodies was 630 c.c. The combined bulk of the oyster bodies themselves was 95 c.c.

Oyster Liquor.

Coli-like microbes were isolated in pure culture from 100 c.c. and 10 c.c., respectively, of the litre, consisting of oyster liquor and sterile water. These coli-like microbes were found to possess the following characters :—

——	Microbe isolated from 100 c.c.	Microbe isolated from 10 c.c.
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	Acid, slight gas.	Acid, slight gas.
Neutral-red broth ,, - - - -	Greenish-yellow fluorescence, ½ positive result.	Greenish-yellow fluoresence.
Broth ,, - -	No indol.	No indol.
Litmus milk ,, - - - -	Acid, no clot.	Acid, no clot.

No liquefaction of gelatine after lapse of 1 month.

The whole litre would then contain coli-like microbes corresponding in number to at least 100, which would be derived from 75 c.c. of oyster liquor. This would give an average of 10 coli-like microbes per oyster or 10 coli-like microbes, that is, in the liquid contents of each oyster. Taking each oyster's liquid contents to be 7·5 c.c., a fair estimate would be more than one coli-like microbe per c.c. of liquor.

Oysters' Bodies.

Coli-like microbes were isolated from respectively 100 c.c., and 10 c.c. of the litre consisting of a mixture of macerated oyster bodies and sterile water. The reactions of these microbes in pure culture were as follows :—

——	Microbes isolated from 100 c.c.	Microbes isolated from 10 c.c.
Gelatine "shake" cultures - - - -	Gas	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid and gas.
Neutral-red broth ,, - - - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, - - - -	No indol.	No indol.
Litmus milk ,, - - - -	Acid and clot.	Acid, no clot.

No liquefaction of gelatine after lapse of one month.

The litre of sterile water and macerated oyster bodies therefore contained coli-like microbes corresponding in number to at least 100, derived, of course, from the oyster bodies. This would work out at 10 coli-like microbes per oyster body. The volume of the oyster bodies was found to be 95 c.c.; the volume of each oyster body would then average 9·5 c.c., and each c.c. of oyster body could be thought of as containing at least one coli-like microbe.

If the probability be considered that all, or the greater number, of the coli-like microbes contained in the washed body of each oyster were derived principally from the stomach juice (of which the volume is about 0·1 c.c.), Division V., App. G.

Comparison, bacteriologically, between (a) the liquor and "washings" of oysters, and (b) the "washed" bodies of oysters.

the ratio volume for volume of the number of coli-like microbes present in the oyster liquor, to the number present in the stomach juice, would be roughly 1 : 100.

EXPERIMENT C. (October 6th, 1903.)

Ten oysters collected from Penryn River at low tide were treated in the manner described in Experiment A. The volume of the oyster liquor was found to be 30 c.c. and that of the oyster bodies to be 80 c.c. The amount of sterile water used for washing was 500 c.c.

Oyster Liquor.

Coli-like microbes were isolated from respectively 1 c.c., and 0·1 c.c. of the litre consisting of oyster liquid and sterile water. The microbes exhibited in pure culture the following reactions :—

——	Microbe isolated from 1 c.c.*	Microbe isolated from 0·1 c.c.*
Gelatine "shake" cultures - - - .	Gas.	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid and gas.
Neutral-red broth ,, - . - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, - - - -	Indol.	Indol.
Litmus milk ,, - - - -	Acid and clot.	Acid and clot.
	No liquefaction of gelatine (one month.)	

The litre which consisted of 30 c.c. of oyster liquor + sterile water would then contain coli-like microbes corresponding in number to at least 10,000; the liquid contents of each oyster would then appear to be responsible for 1,000 coli-like microbes, and taking the volume of liquid derived from each oyster as 3 c.c., there would be at least 330 coli-like microbes in each c.c. of oyster liquor.

Oysters' Bodies.

Coli-like microbes were isolated from 1 c.c. and 0·1 c.c. respectively of the litre consisting of macerated oyster bodies + sterile water. These microbes exhibited in pure culture, the following reactions :—

	Microbe isolated from 1 c.c.*	Microbe isolated from 0·1 c.c.*
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone ,, - - -	Acid and gas.	Acid and gas.
Neutral-red broth ,, - - - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, - - - -	Indol.	Indol.
Litmus milk ,, - - -	Acid and clot.	Acid and clot.
	No liquefaction of gelatine (one month.)	

The whole litre would therefore contain coli-like microbes corresponding in number to at least 10,000, and each oyster body would seemingly contain on an average 1,000 coli-like microbes. Taking the volume of each oyster body as 8 c.c., each c.c. of oyster body would contain 125 coli-like microbes.

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* It is noteworthy that the four microbes, isolated in pure culture in this experiment, were, when submitted to the tests detailed, indistinguishable from typical B. coli.

Comparison, bacteriologically, between (a) the liquor and "washings" of oysters, and (b) the "washed" bodies of oysters.

Therefore, the ratio of the number of coli-like microbes present per c.c. in the oyster body to the number in the oyster liquor would be 125 : 330.

But, if it be considered that the coli-like microbes in the washed oyster were all, or to a great extent, derived from the stomach juice, the ratio of the numbers present per unit of volume in oyster liquor and stomach juice would be 3·3 : 100.

Experiment D. (October 7th, 1903.)

The procedure was the same as that described in Experiment A. Ten oysters collected from the Porthcuel River at low tide were used. The volumes of oyster liquor and of oyster bodies were respectively found to be 60 c.c. and 100 c.c.

Oyster Liquor.

Coli-like microbes were isolated respectively from 1 c.c. and 0·1 c.c. of the oyster liquor. The reactions in pure culture were as follows:—

——	Microbe isolated from 1 c c.	Microbe isolated from 0·1 c.c.
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	No acid, no gas.	No acid, no gas.
Neutral red broth ,, - - -	Greenish-yellow fluorescence.	Negative.
Broth ,, - - - -	Indol.	No indol.
Litmus milk ,, - - - -	Acid, no clot.	No acid, no clot.
	No liquefaction of gelatine (one month.)	

The litre consisting of oyster liquor + sterile water contained coli-like microbes corresponding in number to at least 10,000. The liquid contents of each oyster could then be considered to contain 1,000 coli-like microbes, or each c.c. of oyster liquor to contain on the average 166 coli-like microbes.

Oysters' Bodies.

Coli-like microbes were isolated respectively from 1 c.c.and 0·1 c.c.of the litre consisting of macerated oyster bodies + sterile water. The characters exhibited by these microbes in pure culture were as follows:—

——	Microbe isolated from 1 c.c.	*Microbe isolated from 0·1 c.c.
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid and gas
Neutral-red broth ,, - - - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, - - - -	No indol.	Indol.
Litmus milk ,, - - - -	Acid and clot.	Acid and clot.
	No liquefaction of gelatine (one month.)	

* This microbe is, with respect to these tests, indistinguishable from typical B. coli.

The 10 oyster bodies therefore contained coli-like microbes in number corresponding to 10,000, or each oyster body could then be considered to contain 1,000 coli-like microbes. Taking the bulk of each oyster body as 10 c.c., each c.c. of oyster body would seemingly contain 100 coli-like microbes.

The ratio then of the number of coli-like microbes per c.c, between the oyster body and the oyster liquor, would be 100 : 166.

Comparison, bacteriologically, between (a) the liquor and "washings" of oysters, and (b) the "washed" bodies of oysters.

But if the coli-like microbes contained in the macerated oyster body be considered as principally derived from the stomach juice, the ratio, volume for volume, between the oyster liquor and the stomach juice would be 1·66 : 100.

In the following tabular statement the chief bacteriological results have been summarised :—

1. Experiment.	2. Volume of oyster liquor per oyster in c.c.	3. Volume of oyster body per oyster in c.c.	4. Number of coli-like microbes per c.c. of oyster liquor.	5. Number of coli-like microbes per c.c. of oyster body.	6. Ratio of columns 4 and 5.	7. Ratio, as regards coli-like microbes, of oyster liquor to oyster body per unit of volume on the *assumption* that all the coli-like microbes obtained from the macerated bodies of the oysters were derived from the stomach juice, (taking the volume of the stomach juice as 0·1 c.c. and the volume of the oyster apart its liquor as 10 c.c.).
A	3	9	330	11	33 : 1	33 : 100
B	7·5	9·5	about 1·3	about 1	about 1·3 : 1	about 1 : 100
C	3	8	330	125	2·64 : 1	3·3 : 100
D	6	10	166	100	1·66 : 1	1·66 : 100

It will be noted (column 2) that the volume of oyster liquor per oyster in c.c. varied from 3 (Experiments A and C) to 7·5 (Experiment B).

That the volume of oyster body (column 3) expressed in c.c. varied from 8 (experiment C) to 10 (Experiment D).

That the number of coli-like microbes (column 4) per c.c. of oyster liquor varied from about 1·3 (Experiment B) to 330 (Experiments A and C).

That the number of coli-like microbes (column 5) per c.c. of oyster body varied from about 1 (Experiment B) to 125 (experiment C).

That the ratio of columns 4 to 5 (coli-like microbes per c.c. of liquor and oyster body respectively) is shown in column 6 to have been as follows : 33 to 1 ; about 1·3 to 1 ; about 2·64 to 1 ; and about 1·66 to 1.

Lastly, in column 7 it is shewn that, if certain assumptions be approximately correct, the "coli-yielding fraction" of the body of the oyster contains per unit of volume a larger proportion of coli-like microbes than the liquor. The calculations are based chiefly on the supposition that the bulk of the oyster body is sterile, and that it is the alimentary tract that is rich in coli-like microbes. Such a conjecture is not improbable in view of the facts detailed elsewhere that the gastric juice of the oyster when submitted to quantitative bacteriological examination may contain B. coli or coli-like microbes in great abundance.

If the "coli-yielding fraction" of the body of the oyster be placed at 1 c.c., instead of ·1 c.c., the figures given in column 7, would be altered as follows :—

33 : 10 ; 1 : 10 ; 3·3 : 10 ; 1·66 : 10.

The results as a whole indicate the importance of examining the entire contents of the oyster shell.

Quantitative and qualitative bacteriological examination of the stomach contents of the oyster.

APPENDIX H.

I. A Series of Experiments to ascertain whether B. coli (or coli-like microbes) are present in the stomach of the oyster.

II. A Series of Quantitative Experiments showing that B. coli (or coli-like microbes) may not only be present in the stomach juice of oysters, but may be found there in great abundance.

I. A Series of Experiments to ascertain whether B. coli (or coli-like microbes) are present in the stomach of the oyster.

The oysters were cleaned and opened in the manner described elsewhere. The body of the oyster was seared on the left side, about midway between the ventricle and the hinge. A sterile platinum loop was used to effect an entrance into the stomach, and the stomach juice thus withdrawn was added to tubes containing taurocholate-peptone-glucose medium.

Experiment 1.

(a) Two Penryn oysters (September 5th 1903) were treated in the above manner

Of the contents of the stomach of :—

I. the first oyster, one loopful and 10 loopfuls were separately thus examined, and a positive result was obtained in each instance.

II. Of the second oyster only one loopful was examined, and gave a negative result, no doubt because the amount used was insufficient.

From a gelatine plate made from the 10-loop taurocholate-peptone-glucose culture of Oyster I., a microbe was obtained in pure culture which possessed the following characters :—

—	Stomach juice 10 loopfuls from Penryn oyster.
Gelatine " shake " culture - - - - -	Gas.
Lactose peptone ,, - - - - -	Acid and gas.
Neutral-red broth ,, - - - - -	Greenish-yellow fluorescence.
Broth ,, - - - - -	Indol.
Litmus milk ,, - - - - -	Acid and clot.
	No liquefaction of gelatine (one month).

This microbe is, from the above cultural reactions, indistinguishable from typical B. coli.

(b) Some Whitstable oysters (bought from Spiers and Pond costing 2s. 6d. a dozen) were similarly treated in every respect. Five oysters were examined, viz. :—

(1)	1 loopful of the stomach juice 10 ,, ,, ,, ,,	Positive result in the taurocholate medium.
(2) (3) (4) (5)	1 loopful of the stomach juice	Negative result in the taurocholate medium.

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In the negative cases no doubt the amount used for cultural purposes was insufficient.

From the 10-loopful culture of oyster (1) in the taurocholate peptone-glucose medium, a gelatine plate culture was made from which a microbe was isolated exhibiting in pure culture the following characters :—

——	Stomach juice 10 loopfuls from Whitstable oyster.
Gelatine "shake" cultures - - - -	Gas.
Lactose peptone ,, - - - - -	Acid and gas.
Neutral-red broth ,, - - - - -	Greenish-yellow fluorescence.
Broth ,, - - - - -	No indol.
Litmus milk ,, - - - -	Acid and slight clot.
	No liquefaction of gelatine (one month).

This microbe closely resembles B. coli, but it differs from the typical B. coli in failing to form indol and in clotting milk to a less marked extent than does B. coli.

Experiment 2.

September 8th 1903.

The oysters used for this experiment were cleaned and opened in the manner described elsewhere. The oysters were seared over the gastric region, and an opening into the stomach was made by means of a sterile platinium loop. The loop was used to withdraw some of the juice of the stomach; 10 loopfuls were used for the one examination of each oyster and were added in each instance to a test tube containing sterile taurocholate-peptone-glucose medium.

The following oysters were examined :—

A. Three oysters gathered in the Penryn River at low tide on September 7th. (These oysters were from the same batch as those of the routine experiment 10. Division IV.)

B. Three oysters gathered in the Helford River at high tide on September 7th. (These oysters were from the same batch as those of the routine experiment 16.)

C. Three oysters gathered in the Helford River at low tide on September 7th. (These oysters were from the same batch as those of the routine experiment 17.)

A. From the three Penryn River oysters obtained at low tide, cultures I., II., III., were made, each culture from a separate oyster, 10 loopfuls of the stomach juice being used in each instance.

B. From the three Helford River oysters obtained at high tide, cultures (1) (2) (3) were made, each culture from a separate oyster, 10 loopfuls of the stomach juice being used in each instance.

C. From the three Helford River oysters obtained at low tide, cultures (a) (b) (c) were made, each culture from a separate oyster, 10 loopfuls of the stomach juice being used in each instance.

A. Cultures I., II., III., yielded growth. From each culture, a gelatine plate was made, and from each plate a coli-like microbe was selected, which was further studied in pure culture (coli-like microbes I., II., III.)

B. Only culture (1) gave growth. From it by the gelatine plate method a coli-like microbe was isolated and studied in pure culture (Coli-like microbe (1)).

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C. From culture (a)* a coli-like microbe, isolated in pure culture by the gelatine plate method, was studied further in subculture (Coli-like microbe C (a)).

Characters exhibited by the coli-like microbes, A I., II., III., B (1) and C (a).

Coli-like microbes A I., II., *and* III.

——	A I.	A II.	A III.
Gelatine "shake" cultures - -	Gas.	Gas.	Gas.
Lactose peptone " - -	Acid and gas.	Acid and gas.	Acid and gas.
Neutral-red broth " - -	Greenish-yellow fluorescence. ½ positive result.	Greenish-yellow fluorescence. ½ positive result.	Greenish-yellow fluorescence. ½ positive result.
Broth " - -	Indol.	Indol.	Indol.
Litmus milk " - -	Acid and clot.	Acid and clot.	Acid and clot.

None of these microbes liquefied gelatine within 1 month.

Coli-like microbes B (1) *and* C (a)

——	B (1)	C (a)
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone " - - - -	Acid and gas.	Acid and gas.
Neutral-red broth " - - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth " - - - -	No indol.	Indol.
Litmus milk " - - - -	Acid, no clot.	Acid and clot.

Neither of these microbes liquefied gelatine within 1 month.

It is noticeable that the microbe C (a) was, when submitted in pure culture to the tests enumerated above, indistinguishable from typical B. coli. Practically speaking, microbes A I., A II., and A III., may also be placed in the same category.

It is apparent from the foregoing experiment that oysters derived from the Penryn and Helford Rivers are liable to contain within their stomachs B. coli or coli-like microbes. It is especially interesting to note the isolation in the case of microbe C (a), from a Helford River oyster, of a micro-organism indistinguishable, in the cultural reactions to which it was submitted, from typical B. coli, since the Helford River layings are apparently remote from any proximate sewage pollution.

EXPERIMENT 3.

September 16*th* 1903.

Two oysters (a and b) obtained from the Penryn River were washed in the manner described elsewhere and, after opening with the usual precautions, the stomachic region was seared; a sterile platinum loop was then employed to make an opening in each instance into the stomach. A sterile pipette was used in each case to inoculate a 10 c.c., tube of taurocholate-peptone-glucose medium (cultures A and B).

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* Failures as regards cultures B (2) and (3); and C (b) and (c) were probably due to using for cultural purposes an insufficient amount of material.

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The characters of the coli-like microbes isolated from these cultures are respectively shewn as follows :—

—	A	B
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid and gas.
Neutral-red broth ,, - - - -	Greenish-yellow fluorescence.	Greenish-yellow fluoresence.
Litmus milk ,, - - - -	Acid, no clot.	Acid and clot.
Broth ,, - - - -	No indol.	Indol.

Neither of these two microbes liquefied gelatine within 1 month.

It will be noted that the stomach contents of these oysters contained in one case a microbe indistinguishable by the detailed tests from typical B. coli, and in the other a coli-like microbe which differed from typical B. coli in that it produced no indol in broth and failed to clot milk.

The foregoing series of experiments affords an interesting proof that oysters derived from the layings in the Penryn and Helford Rivers, and also Whitstable natives (as placed on the market) are liable to contain within their stomachs coli-like microbes, and in some instances, microbes, which are, when submitted in pure culture to the subcultural reactions detailed in the foregoing description of the experiments, indistinguishable from typical B. coli.

II.—A Series of *Quantitative* experiments showing that B. coli (or coli-like microbes) may not only be present in the stomach juice of oysters, but may be found there in great abundance.

Experiment A.

September 23rd, 1903.

The oysters used for this experiment were 10 in number, and were derived from the Penryn River, five being collected at high and five at low tide. The washing of the oysters was carried out in the manner described in detail elsewhere. Then with a sterile knife the concave shell was removed, and each oyster was washed under the tap and left adhering to the remaining valve. The stomachic region was next seared, and a sterile platinum loop was used to effect an entrance into the stomach. Through this opening the liquid stomach contents were removed from the oysters by means of a sterile pipette to a sterile watch-glass. The operations require great care and some manipulative skill. As each oyster seemingly contains on the average only a little more than 0·1 c.c. of liquid in its stomach, to obtain out of the 10 oysters the 1 c.c. necessary for the subsequent procedure is not easy.

From the mixture in the watch glass 1 c.c. was withdrawn with a sterile 1 c.c. pipette to inoculate a tube containing 9 c.c. of sterile broth (1). 1 c.c. of (1) was added to a second 9 c.c. broth tube of sterile broth (2), and so on by the decimal mode of dilution to tube (5).*

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* These primary broth cultures (1 to 5) tested on the 6th day after inoculation yielded indol in tube (5) that is ·0001 c.c. of stomach juice. Further, from the original broth culture representing 0·1 c.c. of stomach juice, a microbe indistinguishable from B. pyocyaneus was isolated. 1 c.c. of a pure culture of this microbe in broth injected into a guinea pig caused the death of the animal in 48 hours, and the microbe was subsequently isolated in pure culture from the heart's blood of the animal.

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From each of the primary broth cultures 1 c.c. secondary cultivations were at once made into bile-salt-peptone-glucose tubes. Gelatine plate cultures were made from the tubes giving positive results, and coli-like microbes presenting the following characters, were isolated from the cultivations representing $\frac{1}{100}$ and $\frac{1}{1000}$ c.c. respectively of stomach juice :—

——	Stomach juice. 0·01 ($\frac{1}{100}$) c.c.	Stomach juice. 0·001 ($\frac{1}{1000}$) c.c.
Gelatine "shake" cultures* - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid and gas.
Neutral-red broth ,, - - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, - - - -	No indol.	Indol.
Litmus milk ,, - - - -	Acid and clot.	Acid and clot.

It is worthy of note that the *stomach juice* of these Penryn oysters contained in $\frac{1}{1000}$ c.c. a microbe which was, when submitted to the tests detailed, indistinguishable from typical B. coli.

Experiment B.

September 24th 1903.

Ten Penryn oysters were treated in precisely the same manner as those of the previous experiment.

The (5) primary broth culture gave a positive result as regards indol, that is, ·0001 c.c. of stomach juice.

The coli-like microbes after isolation in pure culture from the bile-salt-peptone-glucose tubes representing $\frac{1}{1000}$ and $\frac{1}{10000}$ c.c. of gastric juice were found to possess the following characters :—

——	Stomach juice 0·001 c.c. ($\frac{1}{1000}$ c.c.).	Stomach juice 0·0001 c.c. ($\frac{1}{10000}$ c.c.)
Gelatine "shake" cultures* - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid and gas.
Neutral red broth ,, - - - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth ,, - - - -	Indol.	No indol.
Litmus milk ,, - - - -	Acid and clot.	Bleached, no clot.

In this experiment the *stomach juice* of ten Penryn oysters was found to contain microbes indistinguishable when tested as above from typical B. coli in amount corresponding to 1,000 per c.c. of the juice. Further, there were present coli-like microbes in amount corresponding to 10,000 per c.c. of stomach juice, but the majority of these microbes differed from typical B. coli in that they neither clotted milk nor formed indol in broth culture.

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* None of these microbes liquefied gelatine within one month.

Experiment C.

September 26*th*, 1903.

Division V., App. H.

Quantitative and Qualitative Bacteriological Examination of the stomach contents of the Oyster.

Ten Penryn oysters were treated in the same manner as those of the two previous experiments. From the bile-salt-glucose peptone tubes gelatine plate cultures were made and two strains of coli-like microbes representing respectively $\frac{1}{1000}$ and $\frac{1}{10000}$ c.c. of gastric juice were isolated and studied in pure culture with results as follows:—

——	Stomach juice 0·001 c.c. ($\frac{1}{1000}$ c.c.)	Stomach juice 0·0001 c.c. ($\frac{1}{10000}$ c.c.)
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone „ - - - -	Acid and gas.	Acid and gas.
Neutral-red broth „ - - - -	Greenish-yellow fluorescence.	Greenish-yellow fluorescence.
Broth „ - - - -	Indol.	Indol.
Litmus milk „ - - - -	Acid, no clot.	Acid, no clot.

Neither of these microbes liquefied gelatine within one month.

It will be seen from the result of this experiment, that coli-like microbes were found to be present in the stomach juice of the Penryn oysters in amount corresponding to 10,000 per c.c.

From the foregoing series of experiments, it is obvious that the stomach of an oyster may contain B. coli or coli-like microbes in large numbers. It would probably be a safe estimate to say that Penryn oysters may contain B. coli or coli-like microbes in number corresponding to at least 1,000 per c.c. of stomach juice. If the volume of the stomach juice be taken at 0·1 c.c., then each oyster might be considered to contain in its interior 100 B. coli or coli-like microbes. Quantitative determinations of this sort show the necessity of examining bacteriologically the whole contents of the oyster shell. The stomach of the oyster would indeed seem to represent per unit of volume accumulation of B. coli or coli-like microbes.

APPENDIX I.

Division V., App. I.

The Question of Error arising from Manipulative procedure.

Experiments to ascertain whether the B. coli met with within the shell of the oyster may have been derived from the exterior of the shell or from the manipulative procedure involved in the opening and examination of the shell contents.

EXPERIMENT A.

August 26th, 1903.

The following experiment was made in order to see whether the procedure of the routine experiment was free from any error caused by accidental contamination, and the following extra precautions were taken.

An oyster, gathered from Helford River, at high tide, on August 25th, was cleaned as usual, and then *immersed for* $\frac{1}{4}$ *hour in* 1 : 500 *corrosive sublimate solution.* The hands of the experimenter were similarly sterilised, both hands and oyster being afterwards washed with sterile water. The oyster was then opened on a sterile cloth, with a sterile knife, and cut up as usual with sterile scissors, and the whole contents of the shell were transferred to 100 c.c. taurocholate-peptone-glucose broth in a flask (culture A), and of this mixture 10 c.c. was withdrawn with a sterile pipette, and placed in a sterile test tube (culture B), and separately incubated.

The oyster employed was one of the same series as those used for experiment 8 of the routine analysis.

As was anticipated, microbes indistinguishable from B. coli were isolated in pure culture from both cultures A and B, and both varieties of B. coli were typical yielding on subculture results as follows:—Gas in gelatine "shake" cultures; acid and gas in lactose peptone cultures; fluorescence in neutral-red broth cultures; acid and clot in litmus milk cultures; indol in broth cultures. No liquefaction of gelatine (one month.)

EXPERIMENT B.

September 2nd, 1903.

The oysters used in this experiment were gathered from the Porthcuel River on September 1st. Two oysters, after being cleaned in the manner described elsewhere were *placed in a 1 per cent. solution of mercuric chloride (corrosive sublimate) for* 15 *minutes.* The hands of the experimenter were washed, sterilised with a 1 : 1000 solution of corrosive sublimate, and then both oysters and hands were rinsed with sterile water. The oysters were then opened and were severally thus treated, viz., the liquid contained in the shell and also the body of the oyster, after it had been cut up with sterile scissors, were respectively added separately to two flasks (A and B) containing 50 c.c. sterilised taurocholate-glucose-peptone medium, and then incubated at 37°C. B. coli, typical with regard to the tests employed, was isolated from flask A and a coli-like microbe from the B flask. Their characters were as follows:—

——	A flask.	B flask.
Gelatine "shake" cultures - - - -	Gas.	Gas.
Lactose peptone ,, - - - -	Acid and gas.	Acid, no gas.
Neutral-red broth ,, - - - -	Greenish-yellow fluorescence.	Negative.
Broth - - -	Indol.	Negative.
Litmus milk - - - -	Acid and clot.	Acid and clot.
	No liquefaction of gelatine (one month).	No liquefaction of gelatine (one month).

Division V., App. I.

The Question of Error arising from Manipulative Procedure.

These two experiments serve to show that the coli-like microbes isolated from oysters obtained respectively from the Helford and Porthcuel Rivers were not to be regarded as in any sense derived from the exterior of the shell of the oyster, since such contingency would be precluded by immersion of the closed oyster in the disinfectant solution. The inference, therefore, to be drawn from the results of these experiments is that the coli-like microbes in question were present within the shell contents of the oyster.

APPENDIX J.

Division V., App. J.

The Relaying of Polluted Oysters in Unpolluted Sea water.

Experiments designed to ascertain whether or not polluted oysters re-laid in sea water remote from sewage pollution can rid themselves within a reasonable time of microbes of undesirable sort.

The object of this experiment was to ascertain whether oysters transferred from layings where the water was known to be polluted with sewage matters to a locality remote from such pollution, possessed the power of ridding themselves to a certain extent of objectionable bacteria, as evidenced by bacteriological examination of the shell contents of the oysters.

With this object in view 250 oysters were transferred on August 29th, 1903, from the Penryn layings to Falmouth Bay in the position indicated on the map (No. 4) accompanying the Helford and Penryn report (Division IV.).

The examination of other 250 Penryn oysters (examined collectively in batches of ten on 25 separate occasions) showed that the number of coli-like microbes present per oyster varied nearly always from 1,000 to 10,000 (*see* Penryn report, Division IV.). These figures may be accepted as "controls" to what follows.

Batches of the oysters laid down in Falmouth Bay on August 29th were taken up from time to time and examined, with the results shewn in the accompanying table.

It will be seen that on September 3rd the number of coli-like microbes corresponded to 1,000 per oyster, or 100 if we elect to insist on rigid fulfilment of all the tests employed.

The number of coli-like microbes in the oysters collected on September 10th and 17th was 100 per oyster.

On September 24th a further sample was collected, and the number of B. coli indistinguishable as regards the tests employed from the typical B. coli of the human intestine was found to correspond to 1,000 per oyster.

The number of spores of B. enteritidis sporogenes per oyster in these four experiments was 10, 10, 100 and 10 respectively.

Before further samples could be collected some mischievous persons cut the rope mooring the receptacle containing the oysters, and the experiment was thus terminated.

Small stress should be laid on the value of this experiment from the positive point of view. B. typhosus and other pathogenic microbes of non-sporing sort might be expected to die long before the more resistant B. coli. On the other hand the results are disappointing in their negative aspects. Had these polluted oysters shewn clear evidence of rapidly freeing themselves from that proportion of coli-like microbes which might be considered in excess of the average number found in oysters laid in localities remote from pollution, the great value of relaying impure oysters in pure water would have been demonstrated in an indirect but convincing manner. It would be unwise, however, to attach much weight to an isolated experiment of this nature.

The bacteriological condition of the water over the oysters is shewn in the accompanying table. It is true that three out of four samples of the water contained B. coli or coli-like microbes either in 10 c.c. or 100 c.c. *But it would be difficult to find in localities suitable for oyster culture around the English coast a purer water for the purposes of relaying oysters.*

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The Relaying of Polluted Oysters in Unpolluted Sea-water.

TABLE showing the Results of the Bacteriological Examination of the Water

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c.							
No.	Time of Collection.				Other Details.	+100 c.c.	÷10 c.c.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.				1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
I.		3	9	1903	Water from Falmouth Bay over the place where the Penryn oysters were laid down to see if they would purify themselves (*see* map).		+	—					
						Characters of coli from the lower dilution - -							
II.		10	9	,,	- - ditto - - ditto - -	+	—						
III.		17	9	,,	- - ditto - - ditto - -	—							
IV.		24	9	,,	- - ditto - - ditto - -		+	—					
						Characters of coli from the lower dilution - -							

in Falmouth Bay over the place where the Penryn oysters were laid down.

3.						4.						5.
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures). Cultures heated to 80° C. for 10 minutes.						**REMARKS.**
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.).	Indol. (Broth cultures, 5 days at 37° C.).	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.).		Lactose peptone medium, + = acid and gas, 48 hours at 37° C.	Neutral-red broth. + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(a)	(b)			1 c.c.	·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.	
+ N.L.	—	+	+	—	½ +	-	-	Negative 10 c.c.			- -	N.B. — Water samples Nos. I., II., III., and IV., correspond with oysters Nos. I., II., III., and IV.
+ N.L.	—	+	+	+	+							
+ N.L.	+	+	+	+	+	-	-	Negative 10 c.c				
						-	-	Negative 10 c.c.				
+ N.L.	—	+	—	Acid and sl. gas.	+	-	-	Negative 10 c.c.				
+ N.L.	+	+	+	+	+							
N.L. signifies no liquefaction, 1 month.												

TABLE showing the Results of the Bacteriological Examination of

1. DESCRIPTION OF THE SAMPLE.						2. Number of B. Coli (or gas-forming coli-like microbes) in 1 c.c. per oyster (average of ten oysters).					
No.	Time of Collection.				Other Details.	1	10	100	1,000	10,000	100,000
	Hour.	Day.	Month.	Year.							
1		3	9	1903	Penryn oysters laid down in Falmouth Bay August 29th.				+	–	
						Characters of coli from lower dilution					-
2		10	9	,,	Penryn oysters laid down in Falmouth Bay August 29th.			+	–		
						Characters of coli from lower dilution					-
3		17	9	,,	Penryn oysters laid down in Falmouth Bay August 29th.			+	–		
						Characters of coli from lower dilution					-
4		24	9	,,	Penryn oysters laid down in Falmouth Bay August 29th.				+	–	
						Characters of coli from lower dilution					-

Penryn Oysters transferred on August 29th 1903, to Falmouth Bay.

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The Relaying of Polluted Oysters in Unpolluted Sea-water.

3.						4.						5.
Chief Biological Characters of the strain of B. Coli present in the number specified in Col. 2.						B. Enteritidis Sporogenes Test. Spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anaerobic milk cultures) per oyster (average of 10 oysters). Cultures heated to 80° C. for 10 minutes.						Remarks.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures 5 days at 37° C.) (a)	(b)	Lactose Peptone Medium + = Acid and Gas, 48 hours at 37° C.	Neutral-red Broth + = Greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
N.L. +	—	+	—	—	+		+	—				Volume of 10 oysters 105 c.c.
N.L. +	+	+	+	+	+							
N.L. +	—	+	+	+	+		+	—				Volume of 10 oysters 115 c.c.
N.L. +	—	+	+	+	+							
(a) + N.L.	—	+	—	—	—			+	—			Volume of 10 oysters 90 c.c.
(b) + N.L.	—	+	—	—	—							
(c) + N.L.	—	+	—	—	—							
(a) + N.L.	—	+	—	+ slight gas	+							
(b) + N.L.	+	+	+	+	+							
(c) + N.L.	+	+	—	+	+							
+ N.L.	+	+	+	+	+		+	—				Volume of 10 oysters 90 c.c.
+ N.L.	+	+	+	+	+							
N.L. signifies no liquefaction, 1 month.												N.B. — Oyster Samples Nos. I., II., III. and IV. correspond to Water Samples Nos. I., II., III. and IV.

APPENDIX K.

Division V.,
App. K.
The Daily
Bacteriological
Examination of
Oysters placed
under Artificial
Conditions.

Experiment designed to ascertain the length of time that B. coli or coli-like microbes can persist in oysters when the latter are separated from their natural environment and placed under artificial, and, if the term be admissible, "dry" conditions.

The oysters selected for this experiment were obtained from Bean's Beds, West Mersea. The object of the experiment was to ascertain how long B. coli or coli-like microbes survive in oysters divorced from their natural environment and the presence of liquid pabulum; or, to put it another way, to ascertain whether B. coli or coli-like microbes persist in the oyster until and after the commencement of that putrefaction which is consequent on the withdrawal of the elements necessary for the life processes of the oyster.

The oysters were laid out in a dry and cool place, whence one oyster was taken daily for examination in the laboratory.

In opening the oyster and in sterilising the hands of the operator the precautions detailed elsewhere were taken.

The oyster was then cut up with sterile scissors in its concave shell. A sterile pipette was used to transfer 1 c.c. of the liquid thus obtained to a sterile bile salt broth tube. A second c.c. of oyster liquid was added to a tube containing 9 c.c. of sterile distilled water (dilution 1). One cc. (= 0·1 c.c. of oyster liquid) was taken from this tube (dilution 1), and added to a second tube containing 9 c.c. of sterile distilled water (dilution 2). One c.c. of dilution 2 (= ·01 c.c. of oyster liquid) was added to a third tube containing 9 c.c. of sterile distilled water forming dilution (3) (of which ·1 c.c. = ·001 c.c. of oyster liquid). Sterile pipettes were used to inoculate sterile bile salt broth tubes respectively from dilutions 1, 2, 3, with ·1 c.c., ·01 c.c. and ·001 c.c. of oyster liquid respectively. The first oyster was examined on the day that the oysters were laid out (first day).

After the first few days the oysters were found to be drying up, and when a second c.c. of liquid wherewith to make the dilutions was unobtainable, ·1 c.c. of oyster liquid was used to inoculate a sterile bile salt broth tube.

The oysters were kept under observation for 12 days, and only on the 9th day, was the attempt to isolate a coli-like microbe from the medium employed unsuccessful. On the 11th day no oyster was examined.

After the 12th day the experiment was perforce abandoned because all the remaining oysters were gaping and showed signs of putrescence.

Previous to this great care was exercised in selecting in each case a seemingly healthy oyster for experiment.

The microbes were isolated in pure culture from the original medium by the gelatine plate method, as a necessary preliminary to observation of their subcultural reactions in various media.

The microbes isolated exhibited with regard to the tests in question the following characters:—

Day.	Amount of Oyster Liquid.	Gelatine "Shake" Cultures.	Lactose Peptone Cultures.	*Neutral-red Broth Cultures.	Broth Cultures.	Litmus Milk Cultures.
1st.	1 c.c.	Gas.	No acid, no gas	Negative.	No indol.	Alkaline.
2nd.	1 c.c.	Gas.	Acid and gas.	Positive.	No indol.	Acid and clot.
	0·1 c.c.	Gas.	Acid, no gas.	Negative.	No indol.	Acid, no clot.
3rd.	1 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot

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The Daily Bacteriological Examination of Oysters placed under Artificial Conditions.

Day.	Amount of Oyster Liquid.	Gelatine "Shake" Cultures.	Lactose Peptone Cultures.	*Neutral-red Broth Cultures.	Broth Cultures.	Litmus Milk Cultures.
4th.	1 c.c.	Gas.	Acid and gas.	Positive.	No indol.	Acid and clot.
5th.	1 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
	0·1 c.c.	Gas.	Acid and gas.	Positive	No indol.	Acid, no clot.
6th.	1 c.c.	Gas.	No acid, no gas,	Negative.	No indol.	Acid, no clot.
7th.	(*a*) 0·1 c.c.	Gas.	Bleached, no gas.	Positive.	No indol.	Acid, no clot.
	(*b*) 0·1 c.c.	Gas.	Bleached, no gas.	Positive.	No indol	Acid, no clot.
8th.	1 c.c.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.
9th.	No coli-like microbes could be isolated.					
10th.†	0·1 c.c.	Gas.	Bleached, no gas.	Negative.	No indol.	Acid, no clot.
11th.	No oyster was examined.					
12th.†	Macerated oyster body.	Gas.	Acid and gas.	Positive.	Indol.	Acid and clot.

No liquefaction had occurred in any of the gelatine "shake" cultures after lapse of one month.

It is of interest to note that microbes isolated from oysters on the 3rd, 5th, 8th and 12th days respectively of this experiment were indistinguishable with regard to the tests employed, from the typical B. coli of the human intestine. Therefore in one oyster typical B. coli was capable of surviving within the oyster under the conditions of storage for no less than a week. The examination on the 12th day, although merely qualitative in character, revealed the presence within the oyster of living B. coli which were found to be typical.

It will be seen that out of 13 coli-like microbes isolated, 4 (30 per cent.) were indistinguishable by the test employed from the typical B. coli of the human intestine, and that of the 13 microbes, isolated from 10 oysters, 5 (38 per cent.) were derived from 0·1 c.c. of the oyster liquid, *i.e.*, 40 per cent. of the oysters contained coli-like microbes in the proportion of about 100 per oyster (taking the volume of the oyster as 10 c.c.). Five of the oysters (50 per cent.) contained coli-like microbes in the proportion of 1 per c.c., that is, making the foregoing assumption, 10 coli-like microbes per oyster. The last oyster tested on the 12th day was unfortunately too dry to yield 1 c.c. of liquid when cut up. But it contained at least one microbe within it which, by the tests employed, could not be distinguished from typical B. coli.

It is obvious that B. coli, originally present in oysters, may not lose its vitality for more than a week under the conditions of experiment.

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* "Positive" indicates that a greenish-yellow fluorescence was produced in this medium. "Negative" indicates that this change did not occur.

† The oyster was too dry to yield 1 c.c. of liquid.

APPENDIX L.

Division V., App. L.

The Bacteriological Examination of Oysters as placed on the Market for Sale.

The results of the bacteriological examination of oysters bought either in the market or at well-known fish shops or restaurants.

The facts recorded in the accompanying table, may be summarised very briefly as follows :—

The first three experiments* deal with the bacteriological examination of the best Anglo-Dutch oysters costing 2s. per dozen, and bought at Sweeting's.

In the first experiment, typical B. coli was present in the proportion of 10 per oyster, but there were less than 10 spores of B. enteritidis sporogenes per oyster

In the second experiment, the number of coli-like microbes was 100· per oyster, and the number of spores of B. enteritidis sporogenes both in this and the third experiment was at least 10 per oyster.

In the third experiment each oyster on the average contained typical B. coli in $\frac{1}{100}$ part of its entire bulk.

Experiments 4, 5, 6, and 7 deal with the bacteriological examination of Whitstable oysters bought respectively at Spiers and Pond's ; Sweeting's ; Driver's and Scott's, and costing 3s. 9d. (1½ dozen) ; 3s. (1 dozen) ; 3s. 9d. (1½ dozen) ; and 3s. 6d. (1 dozen) respectively.

In experiments 4, 6, and 7, the number of coli-like microbes was 100 per oyster. In experiments 6 and 7, typical B. coli was isolated from the lower dilution in each case, so that it may be represented that each oyster contained 100 coli-like microbes, and 10 typical B. coli. As regards experiment 4, the coli-like microbe did not clot milk, nor produce indol in either dilution. In experiment 5, the number of coli-like microbes was excessive, namely, 10,000 per oyster, but in neither dilution could typical B. coli be found.

As regards the B. enteritidis sporogenes test, the results were :—Less than ten ; at least 100 ; 10 and 10 spores per oyster in experiments 4, 5, 6 and 7 respectively.

Experiment 8 deals with the examination of a batch of Portuguese oysters, bought at Farringdon Market, the price being tenpence per dozen. The number of coli-like microbes and of spores of B. enteritidis sporogenes, was 1,000, and 10, respectively, per oyster. Completely typical B. coli was isolated from the lower dilution, and the coli-like microbe representative of the higher dilution was typical in all respects, except as regards clotting of milk.

Experiment 9 deals with the examination of a batch of Blue Point oysters, bought at Farringdon Market, the price being tenpence per dozen. The number of coli-like microbes and of spores of B. enteritidis sporogenes, was 100, and 100, respectively, per oyster. The coli-like microbe was typical, except as regards indol formation and clotting of milk.

Experiment 10 deals with the examination of Burnham oysters, bought at Sweeting's, at 2*s.* 6*d.* a dozen. The number of coli-like microbes and of spores of B. enteritidis sporogenes, was 100, and 10, respectively, per oyster. The B. coli isolated from the lower dilution was typical in all respects, and the coli-like microbe isolated from the higher dilution failed only as regards clotting of milk, and, to a partial extent, in respect of the neutral red-broth test.

It is of interest to apply to the above results the tentative standards suggested in the Helford and Penryn report, as follows :—

B. coli test.†

Lenient standard (less than 1,000 per oyster).

The Portuguese, and one out of the four samples of Whitstable oysters would be rejected.

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* In each experiment ten oysters were submitted collectively to experiment in the way described elsewhere.

† For the purposes of a broad comparison, no distinction is here drawn between coli-like microbes and typical B. coli.

Stringent standard (less than 100 per oyster).

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The Bacteriological Examination of Oysters as placed on the market for sale.

Two out of three samples of Anglo-Dutch, all four samples of Whitstable, the Portuguese, Blue Points and Burnham oysters would be rejected.*

B. Enteritidis Sporogenes Test.

Lenient standard (less than 100 per oyster.)

The Blue Point sample and one out of the four samples of Whitstable oysters would be rejected.

Stringent standard (less than 10 per oyster).

All would be rejected, except one sample of Anglo-Dutch and one sample of Whitstable oysters.

There are several grounds for hesitating to apply even tentative standards to oysters placed on the market for sale, for example :—

(1) An oyster might have been derived from a relatively pure locality, but at the period when it was submitted to examination the few coli-like microbes originally present might conceivably for some reason or other have multiplied in the oyster.

(2) On the other hand, an oyster might have been derived from a polluted laying, but at the period when it was submitted to examination, the coli-like microbes originally present might conceivably for some reason or other have declined in number in the oyster.

(3) Previous to examination the oysters may have been kept under sanitary or insanitary conditions, placed in clean or dirty water, mixed or unmixed with meal or other substance.

It is worth noting, in conclusion, that all the oysters contained coli-like microbes, and that, in the majority of instances, either in the last dilution yielding coli-like microbes, or in the last dilution but one microbes were isolated, indistinguishable with regard to the tests employed from the B. coli of the human intestinal tract. Further, in the great majority of instances, the B. enteritidis sporogenes test yielded positive results.

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* It is not suggested that any of these oysters were unfit for human consumption. The word " rejected " is used simply to imply that, according to certain provisional standards, some of the samples were open to objection on bacteriological grounds.

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The Bacteriological Examination of Oysters as placed on the market for sale.

TABLE, showing the Results of Bacteriological Examination of Oysters

1. DESCRIPTION OF THE SAMPLE.					2. Number of B. Coli (or gas-forming coli-like microbes) per oyster (average of ten oysters).					
No.	Time of Collection.			Other Details.	1	10	100	1,000	10,000	100,000
	Day.	Month.	Year.							
1	10	8	1903	Anglo-Dutch oysters, bought at Sweeting's, at 2s. per dozen. Best quality.		+	–			
					Characters of coli from lower dilution.					
2	11	8	,,	Anglo-Dutch oysters, bought at Sweeting's, at 2s. per dozen. Best quality.			+	–		
					Characters of coli from lower dilution.					
3	12	8	,,.	Anglo-Dutch oysters, bought at Sweeting's, at 2s. per dozen. Best quality.			+	–		
					Characters of coli from lower dilution.					
4	5	9	,,	Whitstable oysters, bought at Spiers and Pond's, City, 3s. 9d. 1½ dozen.			+	–		
					Characters of coli from lower dilution.					
5	15	9	,,	Whitstable oysters, bought at Sweeting's, 3s. 9d. for 1½ dozen.					+	–
					Characters of coli from lower dilution.					
6	12	10	,,	Whitstable oysters, bought at "Mrs. Driver's" 46, Glasshouse Street, off Piccadilly Circus, at 3s. per dozen.			+	–		
					Characters of coli from lower dilution.					
7	15	10	,,	Whitstable oysters, finest selected, bought at "Scott's" Piccadilly, at 3s. 6d. a dozen.			+	–		
					Characters of coli from lower dilution.					
8	16	9	,,	Portugese oysters, bought at Farringdon Market, at 10d. per dozen.				+	–	
					Characters of coli from lower dilution.					
9	17	9	,,	Bluepoint oysters, bought at Farringdon market, at 10d. per dozen.			+	–		
10	16	10	,,	Burnham oysters, bought at Sweetings', at 2s. 6 per dozen.			+	–		
					Characters of coli from lower dilution.					

bought either in the Market or at well-known Fish Shops or Restaurants.

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The Bacteriological Examination of Oysters as placed on the market for sale.

3.						4.						5.
Chief Biological Characters of the strain of B. Coli present in the number specified in col. 2.						B. Enteritidis Sporogenes Test. Number of spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk cultures) per oyster average of 10 oysters). Cultures heated to 80° C. for 10 minutes.						REMARKS.
Gas. (Gelatine "shake" cultures, 24 hours at 20° C.)	Indol. (Broth cultures, 5 days at 37° C.)	(*a*) Acidity. (*b*) Clot. (Litmus milk cultures, 5 days at 37° C.)		Lactose peptone medium + = acid and gas, 48 hours at 37° C.	Neutral-red broth cultures + = greenish-yellow fluorescence, 48 hours at 37° C.	1	10	100	1,000	10,000	100,000	
		(*a*)	(*b*)									
+ N.L. + N.L.	+ −	+ +	+ +	+ +	+ +		Less than 10 per oyster.					10 oysters measured 110 c.c.
+ N.L. + N.L.	− −	+ +	− +	− +	+ +		+	−				10 oysters measured 80 c.c.
+ N.L. + N.L.	+ +	+ +	+ +	+ +	+ +		+	−				10 oysters measured 90 c.c.
+ N.L. + N.L.	− −	+ +	− −	+ +	+ +		Less than 10 per oyster.					10 oysters measured 70 c.c.
+ S.L. + N.L.	− −	+ +	− −	− −	− +			+	−			10 oysters measured 110 c.c.
+ N.L. + N.L.	− +	+ +	− +	− +	+ +		+	−				10 oysters measured 130 c.c.
+ N.L. + N.L.	− +	+ +	− +	− +	½ pos. +		+	−				10 oysters measured 120 c.c.
+ N.L. + N.L.	+ +	+ +	− +	+ +	+ +		+	−				10 oysters measured 190 c.c.
+ N.L.	−	+	−	+	+			+	−			10 oysters measured 220 c.c.
+ N.L. + N.L.	+ +	+ +	− +	+ +	½ pos. +		+	−				10 oysters measured 110 c.c.
N.L. = No liquefaction one month. .L. = Slow liquefaction.												

Since this report was written a report by Messrs. H. W. Clark and Stephen DeM. Gage to the Massachusetts State Board of Health, on the value of tests for bacteria of specific types as an index of pollution, has reached my hands.

The following extracts are of interest

Page 18.

.........“the ability to demonstrate clearly the presence of a specific sewage organism, such as “B. coli, is an invaluable aid in determining the question of purity or pollution. In many “samples from polluted sources B. coli has not been found in either shell, water, or intestine.”

Page 19.

“In a table following, it will be noticed that of the samples of clams taken at known distances “from a sewer outlet, the greatest percentage giving positive tests were collected one-half to “three-fourths of a mile from this outlet. The water samples collected from one-eighth of a mile “to one and five-eights miles from the sewer outlet also gave a greater percentage of positive tests “for B. coli. Those collected at a distance of one-fourth to one-half a mile also gave a greater “percentage of positive tests for B. coli than did the samples collected nearer the outlet.”

CORRESPONDENCE WITH FOREIGN COUNTRIES AS TO IMPORTED SHELL-FISH.

LETTER FROM THE ROYAL COMMISSION ON SEWAGE DISPOSAL TO THE FOREIGN OFFICE.

Royal Commission on Sewage Disposal,
39, Victoria Street,
Westminster, S.W.,
February 6th, 1903.

SIR,

I am directed by the Earl of Iddesleigh, the Chairman of the Royal Commission on Sewage Disposal, to state, for the information of the Secretary of State, that the Commission have recently had under consideration certain suggestions which have been made to them for the purpose of preventing the contamination of shellfish by sewage.

It seems to be generally admitted that shellfish, so contaminated, may cause disease in man, and that in the interests of public health some protective measures are necessary. But, having regard to the large numbers of shellfish which are imported into this country from the United States, France, Holland, and Portugal, it appears to the Commission that, before proposing restrictions, they should know what is the general distribution of shellfish in these countries, whether any layings, " floats," or storage ponds are so situated as to be liable to pollution, and what steps are taken in each of these countries to secure that no shellfish are placed on the market in a contaminated condition.

The Earl of Iddesleigh would be much obliged if the Secretary of State would communicate with these countries with a view to obtaining this information for the use of the Commission.

I am, Sir,
Your obedient Servant,
(Signed) F. J. WILLIS,
Secretary.

The Under-Secretary of State.
Foreign Office.

PAPERS FORWARDED BY THE FOREIGN OFFICE.

The Under-Secretary of State for Foreign Affairs presents his compliments to the Secretary to the Royal Commission on Sewage Disposal, and, with reference to the letter from the Royal Commission of February 6th last, is directed by the Secretary of State for Foreign Affairs to transmit to him the accompanying paper, noted in the margin, respecting the contamination of shellfish in the United States.

Her
o. 44,
rcial.

Foreign Office,
April 8th, 1903.

[ENCLOSURE.]

[Copy. No. 44, Commercial.]

Washington,
March 27th, 1903.

MY LORD,

On receipt of your Lordship's despatch No. 8 of this series of the 12th ultimo, I addressed a Note to the Secretary of State of the United States requesting that I might be furnished with particulars as to the general distribution of shellfish in this country, with reference to their liability to contamination by sewage, and as to the steps taken to prevent shellfish so contaminated from being placed on the market.

I have now the honour to transmit to your Lordship herewith copy of a letter from the United States Commissioner of Fish and Fisheries, which has been forwarded to me by Mr. Hay in response to my enquiry, containing the information desired by the Royal Commission on Sewage Disposal.

I have, &c.,
(Signed) MICHAEL H. HERBERT.

The Marquess of Lansdowne, K.G.,
&c., &c., &c.

[Copy.]

United States Commission of Fish and Fisheries,
Washington, D.C.,
March 21st, 1903.

SIR,

This Commission has the honour to acknowledge the receipt of your letter of February 28th, enclosing copy of a Note from the British Embassy, dated February 24th, concerning the distribution of shellfish in the United States and the measures adopted to prevent their pollution from sewage. As the oyster is the only shellfish which is exported in important quantities from the United States, it is assumed that the enquiry relates especially to that species.

The oyster is found on the Atlantic and Gulf coasts from Cape Cod to the Rio Grande, but the most prolific fisheries are in Long Island Sound and vicinity, New Jersey, and Chesapeake Bay. The locality first mentioned is the one from which practically all of the exported oysters are derived. There are no general measures regulating or restricting the laying down or floating of oysters in localities subject to pollution, but the State and Local Boards of Health are alert to the danger of infection from this source, and enquiries instituted since the receipt of your letter, as well as the previous experience of this Commission, indicate that proper sanitary measures are rigidly enforced, and that the practice of floating oysters is not permitted in regions subject to contamination. The dealers themselves, for the protection of their own trade, have also shown a proper regard in this matter during the past decade, and it is believed that, considering the almost universal consumption of oysters in the United States, comparatively few cases of infectious disease can be traced to this source.

Very respectfully,
(Signed) G. M. BOWERS,
Commissioner.

The Honourable Francis B. Loomis,
&c., &c., &c.

The Under-Secretary of State for Foreign Affairs presents his compliments to the Secretary to the Royal Commission on Sewage Disposal, and, with reference to the letter from the Secretary of the 6th of February last, is directed by the Secretary of State for Foreign Affairs to transmit to him, to be laid before the Royal Commission, the accompanying paper, noted in the margin, respecting the contamination by sewage of shellfish in France, and the steps taken to prevent shellfish so contaminated from being placed on the market.

Sir E. Monson, No. 147, Commercial (in original).

It is requested that this paper may be eventually returned to this Department.

Foreign Office,
June 19th, 1903.

[Enclosures.]

MEMORANDUM.

The regulations existing in France, which may be considered as tending in a general manner to prevent the contamination of waters where shellfish are cultivated, are contained in a Decree of the 4th July, 1853, respecting the inspection of coast fisheries. In virtue of the provisions of this Decree, " The owners of workshops situated on the coast are forbidden to discharge into the sea, rivers, and canals, waters which have been used in their industries of a nature to cause the destruction of fish."

Article 148 of a Decree of the 19th November, 1859, relating to the inspection of coast fisheries, further prohibits the disposal of filth in oyster beds or depositories for shellfish.

In addition to these regulations, instructions have been issued to the local fishery authorities to cause a special inquiry to be made with regard to the salubrity of the water in all cases where permission is asked for the establishment of shellfish beds, and, if necessary, to demand a bacteriological analysis of the water.

If the water is found to be contaminated, owing either to the neighbourhood of sewers discharging polluted water or any other cause, the authorisations are refused.

As a result of a general inquiry made along the French coasts, the Fishery Administration ordered the suppression or the removal of certain shellfish breeding establishments which were pointed out to them as being suspicious.

With regard to the inspection of the produce brought to market, the officials entrusted with this duty by the municipalities concerned take such steps as are considered necessary in the interest of the public health, and seize and condemn all fish or shellfish deemed unsuitable for consumption.

The British Vice-Consul at Bordeaux reports that at Arcachon no precautions are taken against contamination for the reason that no sewage is discharged into the bay, and notwithstanding the enormous quantity of oysters consumed locally, typhoid fever is practically unknown.

The British Vice-Consul at La Rochelle reports that there is an oyster-breeding establishment in the river Sendre producing about 20,000,000 oysters annually, and samples recently taken from these beds and examined by the Board of Health were found to be free from typhoid bacilli.

The British Vice-Consul at Cherbourg reports that the oyster fisheries in that district are in the neighbourhood of St. Vaast, and round the small islet of Tatihou, and are well removed from danger of contamination by sewage from the towns.

Report by Mr. Palmer-Samborne.

Report by Dr. F. Lalesque.

A report drawn up by Mr. Palmer-Samborne, Vice-Consul at Bordeaux, is herewith enclosed, as also a report by Dr. Fernand Lalesque, President of the Scientific Association of Arcachon. It will be observed that in the former report it is stated on the authority of several medical men that " the oyster is endowed with wonderful digestive powers, so that even if it absorbs typhoid or other germs they become innocuous after a short time, and that of all food capable of transmitting typhoid fever, the oyster is the least dangerous on account of its power of absorption."

H. Commiher.

Paris, June 16th, 1903.

REPORT BY MR. PALMER-SAMBORNE.

OYSTER CULTURE IN FRANCE.

Origin.

From time immemorial natural oyster beds have existed in the Bay of Arcachon, which is about fifty-three miles in circumference and covers an area of about 34,000 acres. Up to the year 1841, the bay was quite isolated from the rest of France, which rendered the transport of oysters expensive and difficult, so that the natural beds proved sufficient for the local wants. The construction of the railway from Bordeaux to La Teste completely changed these conditions, the beds being rapidly depleted ; but the French Government stepped in and stopped over-dredging of the natural beds, as well as encouraging the artificial culture of oysters.

Situation

The nearest beds to the town of Arcachon, which is the only place of any size on the bay, are situated on the banks of Aram, a mile from the nearest point of the town, and separated from the land by the deep channel of Eyrac. The other beds are principally situated on the Isle d'Oiseaux, a bank of mud and sand in the middle of the bay.

System o Culture.

At the approach of the spawning season in April, tiles covered with lime whitewash are laid down close to the beds, in such a position that the largest amount of surface may be exposed. The oyster spawn fastens to these tiles, the lime of which aids the formation of the shells. At the approach of winter the tiles are taken up and scraped, thus detaching the young oysters, which are then laid down in wire cages on the beds to increase in size. These cages are so placed that even at low water the oysters are covered with sea-water. Here they remain until they attain the size of an inch in diameter, when they are laid down in beds to gain size. The Bay of Arcachon is highly favourable to the production of oysters, but does not possess the fattening properties of certain other places, such as Marennes, where the oysters find beds of a specially-cultivated grass, which gives them the flavour so much appreciated by connoisseurs in France, and also the green tinge against which there appears to be an unconquerable prejudice in England. I lately sent a friend of mine in London some of these oysters, at the same time telling him not to mind the colour. The fishmonger's man who opened them warned my friend solemnly, " Well, sir, if you eat them 'ere oysters you will be a dead man in ten hours." He still lives and likes the Marennes oysters.

Typhoid germs.

The fact that oysters do convey germs of typhoid is undoubted, and has been proved since the year 1816 by Dr. Pasquier. It is also a fact that an oyster is omnivorous, as is proved by the experiments of Henri Viallanes, who put oysters and mussels in dirty water, which in a short time became clear owing to the absorption by the shellfish of the organic particles held in suspension in the water. The oyster is endowed with wonderful digestive powers, so that even if it absorbs typhoid or other germs they become innocuous, after a short time. *Vide* the experiments of Prof. Ch. Foote, Chantemesses and Chatin. This fact, considering the vast number of oysters consumed annually, would account for the comparatively few number of cases of typhoid fever from oyster eating. In fact, of all foods capable of transmitting typhoid fever, the oyster is the least dangerous on account of its power of absorption.

Inquiry ordered.

In the spring of 1897 the French Government appointed Dr. Mosny to study the conditions of the oyster beds on the French coasts.

Deductio

The oysters laid down in insanitary beds, near sewers, etc., can, no doubt, though rarely, transmit typhoid germs for reasons stated above, but oysters produced in beds, in pure sea water regularly renewed at each tide, cannot convey typhoid fever. Such are the beds of Arcachon, where no sewage is allowed to enter. In Arcachon itself, the only town of any size bordering on the bay, there is no system of main drainage. Each house has its own cemented cesspool, which is regularly emptied, and the contents used to fertilise the soil in the neighbouring lands.

Statistic

In the year 1901 there were 5,879 beds in the bay, from which 291,255,000 oysters were exported, apart from the enormous consumption locally, but all the doctors of the district round the bay are unanimous in declaring a case of typhoid fever is very rare, and not one to their knowledge can be traced to eating oysters.

From the foregoing facts, we have clear proof that the oyster under proper hygienic conditions, such as obtain at Arcachon, is incapable of communicating the germs of typhoid, and, therefore, the lover of oysters can with every confidence enjoy the tasty mollusc, which, though lacking the plumpness of those that come from the well-known fattening beds, yet have the great advantage of being absolutely free from contamination.

Prices.

Very nice little oysters of two years old can be had for 3d. a dozen, while the best the bay produces cost from 7½d. to 10d. per dozen. For the sum of 7s. to 8s. a case of 11 lb., containing from four to six dozen oysters, according to size, can be delivered per parcel post anywhere in Great Britain straight from the producer to the consumer.

REPORT BY DR. FERNAND LALESQUE.

TRANSLATION MADE BY DR. H. TIMBRELL BULSTRODE.

Considerations.

I. "On the Oyster in its Relation to Enteric Fever."

II. "On the Hygienic Value of the Oyster Parks at Arcachon." By Dr. Fernand Lalesque, Corresponding Member of the Academy of Medicine, President of the Scientific Society of Arcachon.

For some months, in addition to general causes making for the decay of the oyster industry there have been added considerations of public health which, erroneously or unjustly interpreted, threaten to ruin the interests, however reputable, of the littoral population of France.

It is for this reason that I propose to set forth (in a succinct account) what is the precise position from the scientific standpoint with respect to the origin of enteric fever from oysters, and to defend against every breath of suspicion the oyster industry of Arcachon.

I.

The Oyster in its Relations with Enteric Fever.

(*a*) Historical facts:

Let us examine in the first place under what circumstances the oyster has been accused of having transmitted enteric fever, confining our inquiry to precise facts alone.

This accusation does not date from yesterday. It was formulated in 1816 by Dr. Pasquier, in a work entitled, "The Oyster from the Medical Point of View."

Pasquier reported the case of a workman who conceived the idea, genial perhaps from the commercial point of view, but deplorable from the hygienic standpoint, of excavating a fattening bed in the moat of an old citadel into which had discharged for centuries the sewage of the garrison.

Greedy for gain, this workman laid down 60,000 oysters, and after some time these oysters were sold without any regard for the disgusting conditions under which they had been prepared for market. Consumed for the first time on September 10th, 1816, nothing happened until the 20th or 21st of the same month, but about that time, that is to say after the lapse of the necessary period of incubation of enteric fever, some cases of that disease declared themselves among the consumers.

Nearer to our own time, in 1894, Dr. William Conn, in America, cited some cases of enteric fever which occurred among certain students of a college in Connecticut after the ingestion of oysters. The oysters in question had been laid down for fattening near to the mouth of a mill stream. On the banks of this stream was a solitary house, the latrines of which emptied themselves directly into it.

Now the oysters had been laid down between the mouth of the stream and the house in question, and 100 yards from it.

Moreover, the attacks first appeared among the students of the college from the 20th to the 25th of October, 1894, and the house had been occupied since October 1st by two ladies who were attacked by enteric fever, and the infected contents of the water-closets of the house emptied directly into the stream which discharged itself on to the oysters laid down 100 yards below.

At about the same time, in 1895, Broadbent, Foote and Cade drew attention in England (Foote is an American H.T.B.) to cases of the transmission of enteric fever by the oyster. English commerce bestirred itself in consequence, and from an inquiry undertaken by the British Government it appeared that the culpable oysters were procured from fattening beds installed at the mouths of rivers—the Thames and others, and near to sewers.

Here is an example cited by the report. It relates to the town of Grimsby, situate on the River Humber. Four important sewers empty themselves into the river, and it is between the mouths of these sewers that the oysters were laid down. Moreover, the town of Grimsby possesses docks in which the water renews itself but little, and into which the sewers empty themselves. Now in these docks there was laid down a quantity of cages, or cases filled with oysters, and the doctors commissioned by the English Government, at the end of the inquiry, accused Grimsby of having contributed to the epidemic caused by oysters.

Finally, in 1896, in France, Professor Chantemesse related to the Academy of Medicine a little epidemic which took place in the Midi of France. On the 15th February, 1896, a merchant of St. Andre-de-Sangonio, in Herault, received a single batch of oysters, which were sold and consumed the same day in the place. Fourteen persons ate the oysters, and all fourteen became ill. Eight were attacked with simple gastro-enteritis (fever, diarrhœa, and vomiting) and remained ill during a week, and four had diarrhœa lasting fifteen to twenty days. Finally, the two others, a young man of twenty and a young woman of twenty-one, were attacked with enteric fever. From what place were the oysters procured? From Cette. In what conditions had they been laid down? The following: The old part of the town is connected with the basin of Phau by a canal which traverses the town, and during its course receives an abundance of excreta and filth. It was into this canal that the oysters, placed in large cases, had been immersed for fattening.

Thus we see that whether we have regard to the facts already ancient of Pasquier or to those more recent which have been reported from America, England or France, each time that the oyster has been able to be accused of having transmitted enteric fever it is always by the repetition of the same circumstances, by the reproduction of the same conditions: the laying down of the oysters in unwholesome places, in the waters of sewers rich, as we well know, in the bacilli of Eberth.

II.

Reality of the Transmission of Enteric Fever by the Oyster.

However, was the incriminated oyster really to blame? In other words, can the oyster, placed in typhoid situations absorb, retain, and then transmit the bacillus of Eberth?

It has been said that the oyster possesses the faculty of discerning in its water of alimentation that which is good for it and that which is bad.

But we have only there a bald statement. Now, in science more than in everything else, we must not take the will for the deed. Science demands precise facts, based on experiment. Now, here are some facts.

Not only can the oyster not discern in its water of alimentation the useful and the harmful, but, on the contrary, it absorbs everything. When one examines under the field of the microscope the liquid drawn from the stomach of an oyster one finds there everything: grains of pollen, debris of algæ, of shells, of crustacea, of diatoms, and, at certain periods of the year, a large quantity of eggs of the same animal.

The Oyster is Omniverous.

But one knows equally how the oyster is glutonous and rapacious. In the experiments carried out at the laboratories of the Scientific Society of Arcachon, Henri Viallanes has shown with what rapidity the mussel and the oyster filter their water of alimentation.

If one places the oyster in a water which is thick, in a little time the water becomes clear, the oyster having filtered it, retaining in its stomach all organic or inorganic particles which the water held in suspension. These two facts render very probable the possibility of the oyster absorbing every bacillus of Eberth which by chance is present in its water of alimentation. The experiments of Foote and those of Chantemesse have changed these probabilities into certainties. In effect, these two observers, having placed some oysters in water rich in the bacillus of Eberth, have, after 24 hours, found the enteric fever bacillus in the various organs of the oyster.

There is therefore no doubt, from the historical facts cited above, that the oyster has been the agent of the transmission of enteric fever.

Rarity of such Transmission.

However, a fact strikes us. If we have regard on the one hand to the quantity of oysters which have been laid down in unwholesome places, and, on the other hand, to the cases of enteric fever which have been brought to light, we see that in relation to the large number of oysters supposed to be contaminated there correspond but few cases of enteric fever.

In fact, the transmission of enteric fever by the oyster, even when laid down in unwholesome situations, is exceptional.

Professor Cornil, Professor Chantemesse, and Dr. Johannis Chatin, in the discussion which arose at the Academy of Medicine on the relation of the epidemic of St. Andre de Sangonio, proclaimed this rarity of the transmission of enteric fever by the oyster.

How is it to be explained? Simply by the fact that the laboratory experiments carried out by Foote and Chantemesse do not realise exactly the conditions which obtain in nature.

An English savant, Klein, has shown that, in effect these experiments, exact though they be, cannot take account of that which happens in nature. Klein laid down a large number of oysters in the docks at Grimsby. After a stay of some time he took them out and examined them, and out of the large number of oysters he discovered the presence of the Eberth bacillus in one only. This proof does not surprise us. It confirms that which Foote and Chantemesse had observed in their experiments: that the oyster in a few days gets rid spontaneously of enteric fever or other germs which it has been able to absorb. This phenomenon explains itself, for Johannis Chatin has demonstrated that with the oyster the phagocytes are endowed with a prodigious activity; not only do the phagocytes surround, enclose, and penetrate the microbe; they go outside the organs to reject their prey.

All these facts, explain, then why and how, when plunged in an infected locality, the oyster appears only very exceptionally to transmit enteric fever.

These facts explain equally why and how of all the foods able to transmit enteric fever the oyster is the least dangerous. For while other foods, milk, water, and vegetables, for instance, keep the enteric fever bacilli which have entered them, the oyster frees itself from them in a short time.

Harmlessness in Healthy Surroundings, and the Hygienic Value of the Oyster Parcs of the Basin of Arcachon.

But if the oyster, placed in the unwholesome conditions of which we are aware, has been able to be exceptionally culpable, is it the same when the mollusc is laid down in its normal situation, in its natural habitat, that is to say, in fresh sea water, living and renewed as is the case in the basin of Arcachon? Then, we can answer boldly, that never has the oyster under these conditions been able to transmit enteric fever. In vain does one search for a single case in the whole of medical literature.

In order to demonstrate this point, Chantemesse procured from a merchant of Paris oysters at the moment of their being delivered to the consumer. He has been able thus to examine oysters coming directly from the sea (Marennes, Tremblade, Arcachon, etc.), and never in any has he discovered the presence of the Eberth bacillus.

And such is the conviction of Chantemesse in this connection, that in his communication he demands that in order to avoid all accidents, oysters shall be laid down, during some days, in the open sea in order to free themselves of impurities or germs which they may contain.

We see, then, a well-defined line of demarcation, a radical difference, to establish. On the one hand, the oyster laid down in unwholesome surroundings, sometimes dangerous; on the other side, the oyster in its normal medium, naturally inoffensive.

These facts established, it is easy to place the oyster beyond harm's way. For that, what is it necessary to do? To interdict, suppress, or protect fattening parcs capable of being polluted by the waters of rivers or of sewers. The Government appears to have comprehended this. Anxious to prevent in the future the recurrence of facts as lamentable as those of St. Andre de Sangonio, it ordered an inquiry to the same lines as had the Government of Great Britain, with the view of ascertaining on what part of the French littoral parcs open to pollution could be found. The Government entrusted the mission to Dr. Mosny, to study the conditions and installations of the parcs of our littoral from the extreme south to the extreme north.

Unfortunately, the governmental zeal was not of long duration, and the report of Dr. Mosny sleeps in peace in the pigeon holes of the Ministry.

But when, in the spring of 1897, Dr. Mosny came into our country, what did he hear and what did he see?

He heard the doctors of the districts say that enteric fever was very rare with us, in spite of the fact that we consume a large quantity of oysters.

I do not know, in fact, that a single doctor practising on the shores of the Bassin d'Arcachon has ever been able to attribute a case of enteric fever to the ingestion of oysters. If oysters abound in the basin, on the contrary, one has searched it in vain for any causes of possible contamination.

In effect Dr. Mosny was able to see a great number of parcs created in a vast bay—the Bassin d'Arcachon measures 84 kilometres in circumference. He saw at high tide 15,500 hectares covered with sea water He saw that at spring tides there entered the bay 370 million cubic metres of fresh water, and at neap tides 170 million cubic metres.

It was not difficult to presume that a similar mass of sea water thus renewed twice in the 24 hours could be polluted.

However the enquiry took place, and it failed to discover the causes, so little likely were they capable of producing pollution.

Now these causes, we have already seen, are of two orders, the rivers and the sewers.

A single river of a very modest dimensions empties itself into the Bassin d'Arcachon, the Leyre. The banks are not inhabited except at a great distance from its mouth. On this side, then, there is no danger.

On the north-east the canal of Lege drains the lakes of Lacanan, Hourtins, etc. One knows the demonstrated purity of these waters, and the banks of this canal neither drain or pass through any human aggregations.

As to sewers, one finds them on the foreshore of the town of Arcachon. They are five in number, carrying, not sewage, but simply the waters of rain and irrigation, an important distinction. All these sewers are very distant from the parcs of the Ile aux Oiseaux, from which they are separated even at low tide by a considerable body of water, the Eyrac channel. The parcs which are nearest to the sewers are the parcs of Arams. They are, however, distant from them by the respectable and reassuring space of more than a kilometre—to be exact, 1,200 metres, according to the map of Mr. Schaerf.

Besides, what is the significance of these sewers of drainage and rain water in relation to the mass of water and the velocity of the current of the fresh, frequently-renewed sea water which passes before their mouths; on the rising tide with a velocity of 0 m. 65 c.m., and a volume of 12 to 1,300 cubic metres per second; on the falling tide with a velocity of 1 m. 55 c.m., and a volume of 1,600 cubic metres per second, figures with which Mr. Engineer Paul has been good enough to furnish me.

The feeble volume of this sewage, distant more than a kilometre from the nearest parcs, loses itself in the rapid mass of sea water which sweeps and carries away the contents of the sewers after having submerged them in this mass of 370 million cubic metres of fresh and running sea water.

To resume, I sum up, may put it synthetically, that the oyster laid down in an unwholesome place, in abundance of sewage, can, albeit very exceptionally, transmit enteric fever. But the fault is not in the oyster, but in the locality. The oyster laid down in its natural medium, that is to say, in sea water, fresh, pure and renewable, cannot transmit enteric fever.

The parcs of the Bassin d'Arcachon, which realise in the highest degree the conditions of the normal environments, are free from all suspicion. The recent bacteriological researches of Professor Ferré are a clear proof of this.

Such are the summarised considerations which has appeared to me useful to publish. And if I were permitted to draw a practical conclusion, I should impress upon our representatives, the elect of universal suffrage, the urgent duty of obtaining from the Government the suppression of the parcs insufficiently protected against pollution if such can be found on the French littoral.

Thus will terminate, in spite of arguments, the lamentable campaign, of which the oyster culturists are the victims.

The Under-Secretary of State for Foreign Affairs presents his compliments to the Secretary to the Royal Commission on Sewage Disposal, and, with reference to the letter from the Royal Commission of February 6th last, is directed by the Secretary of State for Foreign Affairs to transmit to him, to be laid before the Royal Commission, the accompanying paper, noted in the margin, respecting shell fish in Portugal. It is requested that this paper may be returned after perusal.

Cart-
t, No.
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Foreign Office, July 15th, 1903.

[ENCLOSURE.]

No. 46. Commercial.

Lisbon, July 2nd, 1903.

MY LORD,

With reference to your Lordship's despatch No. 4 Commercial, of the 12th of February last, I have the honour to enclose herein a Report, drawn up by the Portuguese Fisheries Commission, containing certain information respecting the general distribution of shell fish in Portugal, and their liability to contamination by Sewage, which has been forwarded to this Legation by the Minister for Foreign Affairs, together with a copy of the Oyster Regulations of October, 1895, and a copy of the Navy Order No. 1, series A. of 1900, mentioned in the above Report.

I have the honour to be with the highest respect,
My Lord,
Your Lordship's most obedient humble Servant.
FAIRFAX L. CARTWRIGHT.

The Marquess of Lansdowne, K.G.,
&c., &c., &c.

Ministry of Marine,
Central Committee of Fisheries.

DISTRIBUTION OF SHELL FISH IN PORTUGAL.

This subject would require a very extensive treatment, if only for the purpose of giving a summary of such a question as the distribution of shell fish; inasmuch, however, as it may be assumed from Sir Martin Gosselin's Note to the Minister for Foreign Affairs, that information is wanted merely in regard to such shell fish as are utilised for human food, it is in this restricted sense that the Central Committee furnish the following details:

There are four edible species of shell fish in Portugal.

A. Oysters.
B. Mussels.
C. Cockles with wrinkled shells.
D. Cockles with smooth shells.

No account is taken of Cephalopodous Molluscs (octopus, inkfish, cuttle fish), to which no interest attaches with reference to the subject under discussion, nor of ocean shells, periwinkles and whelks.

The four species above mentioned may be said to represent the edible shell fish in this country which have a sedentary character and are subject to local influences owing to the intimate relations existing between their organic nature and the immediate surroundings in which they live on account of their want of means of locomotion.

Oysters.

Four species are found in Portuguese waters, but of these the two following are rare, the "ostrea stentina," and the "ostrea cochlear." The two kinds generally in use are the Portuguese oyster, "ostrea angulata," and the oyster commonly known as the French oyster, or the "ostrea edulis."

Both these species are common along the whole country, but they are different in regard to their habitat.

Thus the "ostrea edulis" is an essentially maritime mollusc, and excepting a few natural banks along the coast, which in the Algarves are exploited by means of dredges, it is found in beds of a maritime character presenting little variety, or in waters of a very pronounced brackish character, where the water is not muddy and where the ground on which they develop is composed of sand, stones or shingle.

The principal beds are the following: the lagoon of Obidos and the mouths of the Aveiro and Faro; there are, however, a few beds scattered about at the mouth of the Tagus, the Sado and the Mira, and some of the rivers in the Algarves, but these are disappearing owing to the fact that the beds of these rivers are becoming filled up so that the inland limit of the salt water character is gradually approaching nearer the mouth.

The oyster "angulata" is an oyster found in estuaries, and requires salt water, but of a brackish character, and it lives by preference in muddy surroundings. This may be said to be its ordinary habitat, and such conditions being absent in rivers with granite beds, it is rarely met with in the rivers in the north of Portugal except at the mouth of the Aveiro. Its principal centre is in the Tagus, the Sado, and the Mira, and it is also found in the rivers of the Algarve and the mouth of the Faro.

The river Mira offers a striking example of the different conditions of habitat peculiar to these two species of molluscs. The river has at its mouth a small brackish basin into which it flows laterally, and as its course lies completely along the schist strata of the lower Alemtejo, vast quantities of mud are deposited. At the entry of the mouth some French oyster beds lie scattered about; further up the river, at the distance of about a kilometer, no oysters appear; then again, somewhat further up the Portuguese oyster makes its appearance, forming large banks eight kilometers in extent. A somewhat similar example is also offered by the oysters in the river Tagus. From Trafaria as far as Cacilhas the French oyster breeds here and there, and the Portuguese oyster as well, but it is poor in quality and in size; its big habitat is further up the river, off the great mudbanks of Barreiro, Seisal, Montijo, and it also appears, but more rarely, more inland in the vicinity of Alcochete.

Mussels.

Two sorts are generally used, the Mytilus edulis and the "Mytilus Gallo provincialis." The first is distributed from north to south; the second comes from the Mediterranean, and predominates in the south. The conditions in the existence of these two species are very analogous. They are maritime molluscs like the French or "edulis" oyster. They always appear about the rocky parts of the coast and ascend to a small distance the sea water estuaries. They are found at the mouth of the Aveiro, the Tagus, Sado and in the rivers of the Algarves.

Cockles.

There are four or five kinds in Portugal, and these are always entirely salt water shellfish but a certain species, the "Tapes decussata," gradually adapt itself to brackish waters. The cockles abound in certain maritime districts such as those of Obidos, the Tagus, the Sado, and the estuary of the Faro, but their capture has been so small as to necessitate no restrictive regulations.

There is another species of cockle called "Cardium edule." It is an essentially maritime mollusc, but adapts itself to brackish waters. Under these conditions it undergoes some modification in form. It is more abundant in the south than the north. At the mouth of the Ancao in the Algarves it is found in the largest numbers, and it is used as bait for various kinds of fishing, and as a means of consumption for the poorer classes, and for fishermen when fish is scarce.

CULTURE AND REGULATIONS RESPECTING MOLLUSCS.

Oysters.—The production of oysters has never been highly developed in Portugal. In 1868 the extensive natural oyster beds belonging to the Portuguese species off Montijo on the Tagus were conceded to a private individual, who tried to cultivate this species as if it were the "oyster edulis," but this enterprise fell through.

In Algarves another private individual attempted to rear the French oyster, at first with success, but local circumstances interrupted the attempt. The Regulation of the 1st of October, 1895, is the one which is at present in force in regard to oyster culture. This Regulation does not contain any special provision with reference to the contamination of oyster beds, but in conceding the right of farming oysters or fattening them it is a *sine qua non* that the locality shall not be traversed by sewage matter proceeding from the adjacent villages or towns (Art. 21, No. 4). This Regulation owes its origin to the Central Fisheries Commission, who were of the opinion that this provision offered a sufficient safeguard for public hygiene. It is known that the pathogenical microbes are almost entirely destroyed by the action of salt water accompanied as well by the force of certain cosmic agents, and it is on that account that no necessity arises for taking special measure for oysters bred in natural beds. Reports of subsequent researches have, however, been laid before the Commission by one of the members, in which he alleges that the Portuguese oysters appear in certain conditions to become contaminated. In view as to what has been stated in regard to the habitat of this oyster in brackish waters, it appears that after a prolonged drought lasting until the end of the summer heavy rains fall and form a sheet of water of less density than the waters running in an opposite direction to the tide, the Portuguese oysters situated near the surface are thus immersed for a considerable time in the flood water, and are naturally contaminated by abundant pathogenic bacilli brought down by the water. Many oysters gathered at the turn of the tide must under these circumstances be liable to infection, but it is evident that regulations would not produce much benefit. Recently, the well-known physician Sr. Sabine Coelho, in a report which he read to the Society of Medical Science on the 28th of February, 1903, published in the Medical Contemporary No. 10, Yearly Series No. 21, stated that the hygienic conditions, which should prevail in regard to the breeding grounds of oysters, and referred to in Article 21 of the Regulations above mentioned, are such that they do not call for any further provisions.

Mussels and Cockles.—No regulations have as yet been drawn up in regard to mussels, but as the other two kinds of shellfish do not seem in the opinion of the Commission to warrant any measure from an hygienic point of view, owing to the fact that they are bred in pure or almost pure sea water, the only regulation that appears necessary is one which should relate merely to the preservation of the species as this Commission has pointed out in previous reports. This species of shellfish is not cultivated in Portugal.

Cockles are subject to the Regulations comprised in the Decree of December 30th, 1899, which does not contain any provisions regarding hygiene as already stated; bu only restrictions for the preservation of the species.

This shellfish forms the subject of a special industry, that of "depositos."

There are no regulations moreover in regard to the "berbigao" cockle with wrinkled shell. It is a species which prefers the sea rather than waters of a brackish character; its capture does not require any special provision, except so far as the maintenance of the species is concerned, and this depends entirely on the different localities where the capture is effected as well as on the purpose in view.

With these considerations the Committee beg to offer some further studies on the subject which the Directorate-General of Public Health can with their special knowledge further complete.

This report is therefore accompanied by a copy of the Oyster Regulations of October 1, 1895, and a copy of the Navy Order No. 1 (Series A. of 1900).

The following papers have been received since the Commission presented their Fourth Report, dated December 28th, 1903.

Sir H. Howard, No. 1.

The Under-Secretary of State for Foreign Affairs presents his compliments to the Secretary to the Royal Commission on Sewage Disposal, and, with reference to the letter from this Office of January 2nd, 1903, is directed by the Secretary of State for Foreign Affairs to transmit to him, to be laid before the Royal Commission, the accompanying paper, noted in the margin, respecting the pollution of shellfish in the Netherlands.

Foreign Office, 6 January 1904.

The Hague,
January 2nd, 1904.

No. 1, Commercial.

My Lord,—With reference to your Lordship's despatch No. 5 Commercial of February 12th last, and to my despatch No. 82 Commercial of November 8th last, I have the honour to transmit herewith, for the information of the Royal Commission on Sewage Disposal, the translation of a Note from the Ministry of Waterstaat, Commerce and Industry, with its enclosure, as to the measures taken in Holland to avoid infection of shellfish layings, etc.

I have, etc.,
(Signed) HENRY HOWARD.

The Marquess of Lansdowne, K.G., etc., etc., etc.

NOTE.

The "Committee of Fisheries in the Scheldt and Zealand Channels" has made investigations as to the purity of the water in the neighbourhood of pits and as to that of the pits themselves, as well as the position and arrangement of the latter, and certificates in accordance with the accompany model (English text) will be granted only for oysters taken from preserves found on such investigation to be pure.

The bacteriological examination of the water of the Scheldt and of the oysters taken therefrom is still carried on, as is also the inspection of the pits; while as a special measure, urged by the Chief Inspector of Public Health, a Communal Order has been issued prohibiting the dredging, purchase, or sale of oysters in, or derived from, the harbour of Zierikzee.

MODEL OF CERTIFICATE ENCLOSED.

KINGDOM OF THE NETHERLANDS.

CERTIFICATE.

Valid during the season 15 August 1903—15 August 1904.

The Board of the Fisheries on the Scheldt and Zealand Streams,

declares:

in right of personal investigation and knowledge of, and in right of the result of baccilary investigations, which for some time past have regularly taken place by their order, both of the water and the oysters, that the oysterponds and the rented lots appointed for oysterbreeding, situated within the district of the Scheldt and Zealand Streams,
of Mr.
at
are free from noxious microbes and, by reason of their situation, guaranteed against the danger of infection through sewerage.

The Board aforesaid:

President.

Secretary-Treasurer.

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